

TEXTBOOK OF MEDICINE

TEXTBOOK OF MEDICINE

By Various Authors

EDITED BY

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THIS BOOK IS DEDICATED
TO
THE RIGHT HONOURABLE VISCOUNT NUFFIELD,
O.B.E., F.R.S., M.A., D.C.L., LL.D.
IN APPRECIATION OF HIS MANY
GENEROUS BENEFACTIONS TO MEDICINE

PREFACE TO THE SIXTH EDITION

ONE of the greatest problems of the Editor of a textbook with numerous contributors is to prevent a progressive increase in the size of the book with successive editions. The original object of the Editor was to provide within a reasonable compass and at a moderate price a book which, without becoming a synopsis, would contain the essentials of medicine. With the loyal co-operation of the contributors the number of pages in this edition is practically the same as in the fifth edition though unfortunately owing to war time conditions the price has had to be increased.

The Editor's task has been even more difficult than it was two years ago owing to the wide dispersion of the contributors in war work. I again crave the indulgence of readers in their criticisms of errors which have remained undetected.

The section on Tropical Diseases has been completely rewritten by Wing Commander P. B. Lapscomb. I should like to emphasise that it must not be regarded as in any way a substitute for textbooks devoted to tropical medicine. It does aim, however, at giving a clear and relatively concise account of the more important tropical diseases.

The section on Vitamins and Deficiency Diseases has been rewritten with the collaboration of Squadron Leader W. P. Stumm.

Dr W. D. W. Brooks has largely rewritten the section on Tuberculosis and to a considerable extent that on Diseases of the Respiratory System. He has added a chapter dealing with the treatment of wounds of the chest.

Much new matter has been incorporated in the sections dealing with blood groups, blood transfusion, the use of stored blood, transfusion of plasma and serum, and desiccation of

plasma and serum. The authors offer their sincere thanks to Dr Montague Maizels for his valuable advice on these subjects.

The section dealing with Diabetes Mellitus has been largely rewritten, and stress is laid on the importance of preventing insulin reactions. The treatment of peptic ulcer has also been rewritten.

Dr F. M. R. Walke has rewritten the chapter on Polymenitis and has added a short section on Electroencephalography.

Dr G. B. Dowling has added sections on Scleroderma, Dermatomyositis and the Alopecias.

Minor changes have been made in the sections devoted to sulphonamides, meningococcal infections, pernicious anemia, the use of digitals, and diseases of the thyroid.

In conclusion I would like to thank reviewers and readers of the fifth edition for many helpful criticisms, my fellow-contributors, and many friends, too numerous to mention individually, who have given me the benefit of their advice and help. I am specially indebted to Dr G. V. Steward and Dr D. Stafford Clark for reading the proofs, and to Dr D. E. Price for revising the Index. Finally, I wish to acknowledge the unfailing courtesy, patience, and efficiency of the publishers and printers.

J. J. CONYBEARE

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INFECTIOUS DISEASES

INTRODUCTION

MANY diseases are caused by a recent or remote invasion or infection of the tissues of the host by a parasite (virus, bacterium, protozoon, metazoon, or fungus). The parasite (causal organism) is potentially transmissible from one host to another; hence, such diseases are *infective*. Among them are some caused by readily transmissible specific parasites, and these are known as the specific, or *nento specific*, infectious diseases or "*fevers*"—since "*fever*," which implies raised *temperature* and quickened *pulse*, is a characteristic symptom.

Modes of Infection.—Infection is commonly conveyed directly from one person to another. Save in the enteric group of diseases, where infection is spread by articles of drink or food, and in certain diseases such as plague, typhus, and malaria transmitted by the medium of infected insects, the usual mode of spread is by spray or droplets projected through short distances by sneezing or coughing. The rôle played by fomites, *e.g.*, utensils, bedding, letters, or dust is in the light of recent research assuming increasing importance.

Carriers.—A carrier is one who, although not himself suffering from the specific disease, harbours, and is thus in a position to spread, the causal organism. The carrier state may persist for a varying period after a frank clinical attack of the disease which has rendered the patient himself immune. Such persons are termed "*convalescent carriers*." Persons who have passed through no recognisable clinical attack of the disease can yet carry specific organisms and be immune to the disease; they are healthy or contact carriers whose immunity has been acquired by small repeated sub-clinical doses of infection. The carrier state may be transient or permanent. Non-immunes may carry temporarily, *e.g.*, during latent infection or while incubating the disease.

Incubation Period.—Between infection and clinical attack

is a latent period termed the incubation period, which varies with each disease, and, within certain limits, for the same disease. During incubation the organisms are multiplying and probably in large part being destroyed by the tissues, but ultimately the organisms or their products gain the upper hand, overcome the resistance of the host, and initiate that complex of symptoms and signs by which the "disease" is recognised.

Variations or apparent variations, in the length of the incubation period of the same disease may depend on any of the following factors: (1) Difficulty in fixing accurately the actual date upon which infection took place. (2) Variations in size and virulence of the initial infecting dose and in the existing basal immunity of the host. (3) An ill defined onset particularly characteristic of typhoid fever and whooping cough.

TABLE OF INCUBATION PERIODS

The incubation periods of the commoner acute infectious diseases may be arranged in three groups, *Short*, *Intermediate*, and *Long*.

I *Short within 7 days*

Diphtheria

Cerebrospinal Fever

Hæmolytic streptococcal infections

(a) Erysipelas

(b) Streptococcal puerperal sepsis

(c) Scarlet Fever

II *Intermediate from 7 to 14 days*

Smallpox To prodromal stage 12 days

To rash 14 days

Exanthematic, Louse or European Typhus, 12 to 14 days

Enteric Fever (a) Typhoid 12 to 14 days

(b) Paratyphoid 10 to 12 days

Measles To Koplik's spots 10 to 11 days

To rash 14 days

Whooping-cough To catarrhal stage 7 to 14 days

To whoop 14 to 21 days

III *Long from 14 to 21 days*

Chickenpox, 14 to 21 days

Rubella, 17 to 21 days

Mumps, 18 to 21 days

Period of Invasion—The incubation period is terminated by

the period of invasion. The onset of this period may be abrupt or insidious. Symptoms and signs of the disease appear, and increase in severity up to a phase of maximum intensity which is known as the *fastigium*. Thereafter the disease processes abate and the period of decline or *defervescence* is entered. This is commonly succeeded by the period of *convalescence* and recovery. It is sometimes the case that the disease, after an atypical or ill defined invasion period, does not increase in intensity or severity, on the contrary, the symptoms and signs rapidly abate. The attack is then said to have *aborted*. Latent infections or subclinical attacks so mild as to be clinically unrecognisable are far commoner than was formerly believed to be the case. A frank clinical attack of several of the fevers only occurs in a minority of people actually infected.

Lasting active immunity is commonly produced as the result of an attack of an acute specific infection. By the time the stage of convalescence is reached, specific antibodies have been produced by the tissues in considerable amount. They may, however, fail to be produced, at any rate in sufficient quantity, by the time convalescence is reached, in this case the patient may suffer a *relapse* of the disease if reinfection or reabsorption of toxins should occur. The immunity produced after an attack usually remains at a high level for a number of years, it wanes with time, and although this is a rare event in the case of most of the common fevers a *second attack* may occur at a more or less long interval after the first.

Types of Pyrexia—Rise of temperature is an almost constant manifestation of the acute infections and only fails to occur when the infection is so overwhelming that the tissues are unable to make any effective response. The following types are described—

(a) *Continued*—The temperature although showing the usual evening rise and morning fall, never reaches normal during the twenty four hours.

(b) *Intermittent*—The temperature drops to normal at some time during the twenty four hours. There is usually an evening rise and a morning fall, but occasionally in children the reverse may occur.

(c) *Remittent*—This term is occasionally employed to indicate a temperature which, although not reaching normal, shows a considerable rise and fall during the twenty four hours.

(d) *Hyperpyrexia*—This term is employed for temperatures of 106°F or over.

is a latent period termed the incubation period, which varies with each disease, and, within certain limits, for the same disease. During incubation the organisms are multiplying and probably in large part being destroyed by the tissues, but ultimately the organisms or their products gain the upper hand, overcome the resistance of the host, and initiate that complex of symptoms and signs by which the "disease" is recognised.

Variations, or apparent variations, in the length of the incubation period of the same disease may depend on any of the following factors: (1) Difficulty in fixing accurately the actual date upon which infection took place. (2) Variations in size and virulence of the initial infecting dose and in the existing basal immunity of the host. (3) An ill defined onset, particularly characteristic of typhoid fever and whooping cough.

TABLE OF INCUBATION PERIODS

The incubation periods of the commoner acute infectious diseases may be arranged in three groups, *Short*, *Intermediate*, and *Long*.

I *Short within 7 days*

Diphtheria

Cerebrospinal Fever.

Hæmolytic streptococcal infections

(a) Erysipelas

(b) Streptococcal puerperal sepsis

(c) Scarlet Fever

II *Intermediate from 7 to 14 days*

Smallpox To prodromal stage, 12 days

To rash, 14 days

Exanthematic, Louse or European Typhus, 12 to 14 days

Enteric Fever (a) Typhoid, 12 to 14 days

(b) Paratyphoid, 10 to 12 days

Measles To Koplik's spots 10 to 11 days

To rash, 14 days

Whooping-cough To catarrhal stage, 7 to 14 days

To whoop, 14 to 21 days

III *Long from 14 to 21 days*

Chickenpox, 14 to 21 days

Rubella, 17 to 21 days

Mumps, 18 to 21 days

Period of Invasion —The incubation period is terminated by

the period of invasion. The onset of this period may be abrupt or insidious. Symptoms and signs of the disease appear, and increase in severity up to a phase of maximum intensity which is known as the *fastigium*. Thereafter the disease processes abate and the period of decline or *defervescence* is entered. This is commonly succeeded by the period of *convalescence* and recovery. It is sometimes the case that the disease, after an atypical or ill-defined invasion period, does not increase in intensity or severity, on the contrary, the symptoms and signs rapidly abate. The attack is then said to have *aborted*. Latent infections or subclinical attacks so mild as to be clinically unrecognisable are far commoner than was formerly believed to be the case. A frank clinical attack of several of the fevers only occurs in a minority of people actually infected.

Lasting active immunity is commonly produced as the result of an attack of an acute specific infection. By the time the stage of convalescence is reached, specific antibodies have been produced by the tissues in considerable amount. They may, however fail to be produced, at any rate in sufficient quantity, by the time convalescence is reached, in this case the patient may suffer a *relapse* of the disease if reinfection or reabsorption of toxins should occur. The immunity produced after an attack usually remains at a high level for a number of years, it wanes with time, and although this is a rare event in the case of most of the common fevers a *second attack* may occur at a more or less long interval after the first.

Types of Pyrexia—Rise of temperature is an almost constant manifestation of the acute infections and only fails to occur when the infection is so overwhelming that the tissues are unable to make any effective response. The following types are described—

(a) *Continued*—The temperature although showing the usual evening rise and morning fall never reaches normal during the twenty four hours.

(b) *Intermittent*—The temperature drops to normal at some time during the twenty four hours. There is usually an evening rise and a morning fall, but occasionally in children the reverse may occur.

(c) *Remittent*—This term is occasionally employed to indicate a temperature which, although not reaching normal, shows a considerable rise and fall during the twenty four hours.

(d) *Hyperpyrexia*—This term is employed for temperatures of 106°F or over.

The onset of pyrexia may be abrupt or gradual. In typhoid fever the rise may be progressive over a number of days—the typical “step ladder” pattern. Pyrexia may subside gradually over a number of days (*lysis*) or abruptly in the course of a few hours (*crisis*).

Needless to say, pyrexia is a frequent manifestation of disease, apart from the presence of the specific infectious fevers, and, on the other hand, not all attacks of specific fevers are pyrexial.

Certain acute infective diseases are characterised, at some stage in their course by a more or less typical rash. The changes produced in mucous membranes as the result of infection are called collectively the *enanthem*, those produced in or upon the skin the *exanthem*. The skin picture to which the term exanthem, rash, or eruption is applied is made up of certain primary skin lesions or a combination of these lesions. If more than one type be present the rash is said to be dimorphic or polymorphic (pleomorphic).

The following points must be noted in the examination of a rash —

1 *Distribution* —The *absolute* and *relative* distribution of a rash are most important points in diagnosis. It is necessary to ascertain not only upon what parts of the body the rash is present or absent, but where it is present most profusely. The site first involved, its abundance, and type are important.

2 *Type* —A rash may consist of an *erythema* of any variety, of *macules*, *papules*, *vesicles*, *pustules*, *petechiæ* or *wheals*, or of any combination of these. The lesions may be *discrete* or *confluent*, either generally or locally.

3 *Colour* —This is important, especially in considering the erythematous types of rash.

4 *Itching* —This is an unusual symptom of the acute exanthemata which however, sometimes cause intense irritation. The eruptions of secondary syphilis which must be differentiated from the acute exanthemata, do not itch. The possible effects upon the appearance of the eruption of itching or treatment—local or general—must be considered.

5 *Prodromal Rashes* —A prodromal rash is one which appears and, unless petechial commonly disappears before the rash characteristic of the disease develops. Unless the possibility of a prodromal rash be borne in mind, a serious mistake in diagnosis may be made. Such rashes are either erythematous (scarlatiniform or macular), urticarial or petechial.

SERUM DISEASE OR SERUM SICKNESS

Following the administration of therapeutic sera, the syndrome known as serum disease may occur due to foreign proteins contained therein. Its incidence has been very much diminished by the employment of "protein digested" (globulin modified) products of very low protein content. Serum sickness ordinarily appears between the seventh and fourteenth day after administration. The main features are pyrexia with sometimes a rigor, a rash which is typically urticarial and sometimes polymorphic, and less commonly, adenitis and arthritis. Transient albuminuria is frequent. The duration of serum disease may be from a few hours to three or more days. The rash, which may be confined to the site of injection, is the most constant phenomenon. Whatever other elements are present, wheals can almost always be found on some portion of the body. The urticarial eruption may be associated with a rash of scarlatiniform type. Serum rushes give rise to intense irritation. This can usually be relieved by an alkaline lotion, but in severe attacks the administration of adrenalin hypodermically (5 to 10 minims of a 1 in 1,000 solution) followed by ephedrine ($\frac{1}{2}$ to $\frac{1}{4}$ gr. three or four hourly by mouth) frequently affords rapid relief. In those who are naturally sensitive to protein, signs of serum sickness may appear within a few minutes or hours of administration, and in such patients may be of alarming severity. The symptoms are clinically similar to anaphylaxis. The worst examples occur in those who have never received serum before (*atopics*). Fortunately, only about one in 70,000 persons exhibit this extreme serum sensitiveness or *atopy*. If a period of more than ten days has elapsed between the administration of two doses of serum derived from the same species of animal, the patient may show signs of sensitiveness following upon the injection of the second dose. Hence inquiry should always be made as to any previous administration of serum, and any patient who may be presumed to be serum sensitive owing to lapse of time since the last injection, or who gives a history of asthma, particularly of horse asthma, should be *desensitized* before a therapeutic dose is injected.

The method of desensitisation depends upon the route decided upon for the subsequent injection of the therapeutic dose. If this is to be *intravenous*, then 0.1 c.c. of the therapeutic serum (*not* normal horse serum) diluted in 10 c.c. of sterile isotonic saline solution at body temperature is injected *slowly* into a vein. If symptoms of sensitiveness appear following this

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The *blood picture* shows a polymorphonuclear leucocytosis and eosinophilia.

In the hypertoxic or malignant form of the disease, in which the patient dies in a few hours from overwhelming toxæmia, the only appearances seen post mortem are general congestion of all organs with hæmorrhages into the suprarenals. Apart from this type of case, death in scarlet fever results from complications due either to toxin damage alone, or to invasion of other tissues by the causal or other organisms. Myocardial degeneration, endocarditis, pericarditis, nephritis, suppurative adenitis, arthritis, and septic broncho pneumonia are the pathological conditions most likely to be present at autopsy.

Incubation Period—Two to four days, commonly, extreme limits of one to seven days are recorded.

Classification of Types—Scarlet fever presents the following clinical types—

1 *Simple*—A tonsillitis is followed by manifestations of toxin absorption ranging from trifling to moderate severity.

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are covered with a yellowish exudate which is readily removable. Sometimes the exudate is more tenacious, and may have a membranous character which may be mistaken for faucial diphtheria. The soft palate is injected and presents, typically, a "stippled" appearance. The tongue undergoes the following characteristic changes: (1) "White strawberry" tongue: the dorsum is covered, except at the edges, with a creamy white fur through which the enlarged papillæ project. (2) "Red strawberry" tongue: the fur gradually strips from the edges inwards, leaving, after the lapse of three or four days, a perfectly clean, red, congested tongue with enlarged papillæ. Occasionally the tongue assumes a much darker shade of red, and is then known as a "raspberry" tongue. The enanthem is evidence of a hæmolytic streptococcal invasion of the fauces and when present without the rash is termed "septic sore throat."

Twenty-four to thirty-six hours after the initial symptoms the rash commences to appear. First to be seen upon the neck, it gradually spreads downwards over the trunk and limbs, but rarely appears on the face. The forehead and cheeks are brightly flushed, with a contrasted area of "circumoral pallor." The rash is a *punctate erythema*: points of deep coloration are set in the centres of irregular small islands of bright red erythema which are usually so closely set on the trunk as to be confluent, when an appearance of uniform redness with deeper punctations is produced. Commonly a subicteric tinge can be seen. The rash is sometimes blotchy upon the arms and legs. It may often be seen in its typical form upon the inner sides of the thighs, even when it has commenced to fade upon the upper portions of the body. Occasionally the rash produces itching.

Pastia's Sign consists in the appearance of linear brown staining and tiny petechiæ at the flexures, particularly in the elbow and the popliteal space. This sign is present in a large proportion of cases of scarlet fever. Although not pathognomonic, it may yet afford considerable assistance in the diagnosis of a faded scarlet fever rash. The petechiæ are, of course, evident after the erythematous element has faded. The rash fades in the same order as it appeared, and is followed by *desquamation*, of "pin-hole" type, of the affected skin, first visible at the root of the neck and beneath the clavicles about a week after the appearance of the rash; later, on the trunk, palms (14th day), and soles (21st day).

In the *simple* type of scarlet fever there is frequently some cervical lymphatic glands and a transient

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4 *Surgical*—The infection of wounds or burns, or the genitalia during the puerperium, with the specific organism may result in scarlet fever. The nasopharynx is not infected in these forms which otherwise are indistinguishable clinically from ordinary attacks, and tend to be severe.

Clinical Description—Typically, an *enanthem* is followed by an *exanthem* or rash, but this may fail to appear or be so faint as to escape recognition. The onset is usually abrupt. Sore throat, nausea or vomiting, headache and shivering, rise of temperature to between 100° and 103° F., and tachycardia out of proportion to the pyrexia are the usual symptoms at the onset. The fauces are injected, and, after the first few hours the tonsils either present a clean intensely red appearance or

upon human immunes and non immunes until a suitable dilution for routine use is arrived at. A usual dilution is 1 in 1,000. A "skin test dose" consists of 0.2 c.c. of such a dilution injected intradermally into the skin of the forearm, since "pseudo" reactions are rare, a control injection is usually omitted. Readings of the results, which closely resemble those of the Schick test in appearance are possible in twelve hours. The smallest reaction is to be read as positive. Those who give a positive test are considered to be susceptible to scarlet fever, i.e. including the rash. If the test be negative, immunity to the rash producing toxin but not to tonsillitis, may be presumed.

The percentage of susceptibles in the different age groups closely corresponds, in children, to the percentages of Schick positive reactors. In adolescents, however, the two curves begin to show considerable variation. The percentage of immunes to scarlet fever in these older age groups is higher than the percentage of immunes to diphtheria. The inference is that many more people become immunised to scarlet fever toxin than to diphtheria as the result either of mild unrecognised clinical attacks of the disease or of small repeated "immunising" infections. The great majority of persons who have had an attack of scarlet fever at any time give a negative reaction. The reaction is positive in 80 per cent. of cases of scarlet fever during the first three days of the attack, later, skin immunity is produced and the reaction becomes negative.

(b) The Schultze-Charlton Reaction—The reaction of the tissues to scarlet fever toxin is to produce antitoxin. This is present in the blood of the scarlet fever patient for the first time about eight days after the appearance of the rash, and may be detected for many years after the attack. The blood serum of a convalescent injected *intradermally* into a recent scarlet fever rash will produce local blanching (the Schultze-Charlton reaction) in from six to eight hours. Usually 0.2 c.c. of a 1 in 10 dilution of scarlet fever antitoxin is employed. Although a positive result is pathognomonic, *bright* but *late* rashes or *recent faint* ones may fail to blanch, thus limiting the practical value of the test.

Treatment—Scarlet fever antitoxin has a profound effect upon the toxæmia of the disease. The dosage ranges from 3,000 U.S.A. units *intramuscularly* for the mild case up to 30,000 units *intravenously* for the severely toxic form. Early administration is all important. Within twelve hours, temperature and pulse rate fall, the general symptoms of toxæmia abate or are abolished, and the rash fades, desquama

tion is minimal. In toxic cases the effects are dramatic. Antitoxin has no direct effect on the invasive (septic) features of the disease for which sulphonamides (c.f. p. 70) are indicated.

The patient should be kept in bed for at least a fortnight or longer in the more severe types. Milk diet should be given until the temperature has fallen; fish and minced meat may then be added. There is no advantage in maintaining a milk diet for three weeks, as was formerly advised, with a view to lessening the incidence of nephritis. An early return to a mixed diet does not increase the frequency of this complication, the management of which in no way differs from that required in acute nephritis of other causation. Acute polyarthritides is rheumatic and responds to salicylates. Paracentesis may be required for otitis media. Osteomyelitis of the mastoid and long bones demands prompt surgical measures.

Mode of Spread and Prevention—Scarlet fever is a disease of relatively low infectivity. Close personal contact is usually necessary for its spread, but recently soiled articles may convey infection. Many outbreaks are the result of drinking infected milk have been recorded, and this possible source of infection must be eliminated. Convalescent and "healthy" carriers are numerous. The convalescent carrier may give rise to "return" cases. The specific organisms persist in the throat for at least four weeks and isolation should therefore be maintained for this period. Desquamation may be safely ignored but any breach of mucous membranes, rhinitis or otorrhea should be regarded as possibly infective until the causal organism can be shown to be absent. Concurrent disinfection is important. Terminal disinfection should also be carried out.

The Dick test should be performed on contacts. Susceptibles may be passively immunised by the injection of 1000 to 1000 U.S.A. units of scarlet fever antitoxin. Protection is secured within twenty-four hours and lasts for from ten to fourteen days but no longer.

Active immunisation may be carried out by the injection at weekly intervals of graded numbers of skin test doses (s.t.d.) of scarlet fever toxin. To produce lasting immunity large doses are necessary. The Dicks begin with 670 and increase steadily up to 100 000 s.t.d. in the fifth and last injection. Reactions may prove troublesome and dictate a modified scale. Active immunity enduring commonly for several years is so produced in 90 per cent. of susceptibles.

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Tonsillar and Pharyngeal Diphtheria—The onset is frequently insidious, especially in children There may be nothing to direct attention to the throat until the disease is well established, and this is an important factor in its unnecessarily high mortality The child appears to be poorly, pale tired, and dispirited The temperature is only slightly raised, but the pulse is rapid and of low tension Vomiting is less common than in scarlet fever Examination of the throat by the time the practitioner is called usually shows a definite membrane In tonsillar diphtheria this is generally first visible upon one or both tonsils as a patch of greyish white colour with well defined edges The membrane is definitely growing upon the surface of the tonsil and surrounding it may be a zone of hyperæmia It is firmly adherent to the underlying tissue, but can be pulled off and leaves a bleeding surface In pharyngeal diphtheria membrane is more extensive, invading, in addition to the tonsils, other parts of the pharynx

If treatment is delayed, the membrane tends to spread and its colour to become darker owing to the presence of altered blood, and later owing to necrotic changes There may be characteristic fœtor and œdema of the tonsils and uvula Some degree of cervical adenitis and periaadenitis, except in very mild cases is usual In the hypertoxic or "malignant" type of case this may be so pronounced as to give rise to the appearance—always of very grave prognostic import—known as "bull neck" Albuminuria is frequent, but not constant, at the onset of diphtheria

Anterior Nasal Diphtheria—Though frequently associated with faucial infection, nasal diphtheria often occurs alone Owing to its insidious course it may pass unrecognised for perhaps weeks, during which period the affected child disseminates the disease Typical nasal diphtheria is characterised

particularly those of industrial type, exhibits localised epidemic prevalence. Outbreaks in schools and institutions, once of common occurrence, are now increasingly obviated by the immunisation of the susceptibles. The disease is mainly prevalent during the winter months. Incidence falls chiefly upon children up to the age of ten years. The number of cases occurring in children from ages five to ten exceeds those occurring in children under five, a fact obviously correlated with the increased opportunities for infection occurring in those of school age. Diphtheria is uncommon in infants under one year old, but the maximum case fatality occurs in children under five years of age. In children under ten years of age the sexes are fairly equally affected, above that age females preponderate.

Bacteriology.—The *Corynebacterium diphtherie* (Klebs-Löffler bacillus) includes the *gravis*, *intermedius*, and *mitis* strains. The latter is the least virulent and is sometimes avirulent and, if so, incapable of causing the disease. The bacillus is found in the false membrane characteristic of the disease, and in the throat and nose of convalescents and of a proportion of healthy people. The organism is a non-motile, gram-positive, non-sporing aerobe which produces a soluble exotoxin possessing special affinity for heart muscle and nervous tissue.

Pathology.—The false membrane varies in appearance and thickness according to its age and situation. It occurs in its most typical form upon the tonsils, the pillars of the fauces, uvula, and soft palate. It occurs also upon the epiglottis, and may extend within the larynx partially occluding the glottis. The trachea and bronchi may be invaded, and the membrane may be detached from these structures in the form of a cast or mould. The membrane itself is the result of a combination of fibrinous exudation from, and necrosis of, the superficial layers of the underlying mucous membrane.

Broncho-pneumonia is a common terminal event in the laryngeal form, either as the result of the direct spread of membrane downwards or of infection by secondary organisms. Although generalised, the effects of toxin upon the muscular and conductive tissues of the heart are most evident. The naked eye changes are those of acute myocarditis. Microscopically, the bundle of His (auriculo-ventricular bundle) may be seen, on occasion, to be virtually disorganised. There are no characteristic naked-eye changes in nervous tissue.

Incubation Period.—Usually from two to four days.

Clinical Types.—Diphtheria may be classified according to

the situation of the membrane. The following are the commonest sites: (a) tonsillar, (b) pharyngeal, (c) anterior nasal, (d) laryngeal. Membrane may also occur upon the conjunctiva, the skin, and wounds, diphtheria of the middle ear is of uncommon occurrence.

Tonsillar and Pharyngeal Diphtheria—The onset is frequently insidious, especially in children. There may be nothing to direct attention to the throat until the disease is well established, and this is an important factor in its unnecessarily high mortality. The child appears to be poorly, pale, tired, and dispirited. The temperature is only slightly raised, but the pulse is rapid and of low tension. Vomiting is less common than in scarlet fever. Examination of the throat by the time the practitioner is called usually shows a definite membrane. In tonsillar diphtheria this is generally first visible upon one or both tonsils as a patch of greyish white colour with well defined edges. The membrane is definitely growing upon the surface of the tonsil, and surrounding it may be a zone of hyperemia. It is firmly adherent to the underlying tissue, but can be pulled off and leaves a bleeding surface. In pharyngeal diphtheria membrane is more extensive, invading, in addition to the tonsils, other parts of the pharynx.

If treatment is delayed, the membrane tends to spread and its colour to become darker owing to the presence of altered blood, and later owing to necrotic changes. There may be characteristic fœtor and œdema of the tonsils and uvula. Some degree of cervical adenitis and periadenitis, except in very mild cases is usual. In the hypertoxic or "malignant" type of case this may be so pronounced as to give rise to the appearance—always of very grave prognostic import—known as "bull neck." Albuminuria is frequent, but not constant, at the onset of diphtheria.

Anterior Nasal Diphtheria—Though frequently associated with faucial infection, nasal diphtheria often occurs alone. Owing to its insidious course it may pass unrecognised for perhaps weeks, during which period the affected child disseminates the disease. Typical nasal diphtheria is characterised by a yellowish, blood-stained discharge from one or both nostrils. Examination within the anterior nares may reveal a patch of membrane on the inner or outer walls, or the nares may be occluded by the presence of membrane. Often, however, the membrane may be situated too far back to be seen by ordinary methods of examination. Frequently the skin below the nostrils is excoriated. The child, although not definitely ill, is usually out of condition. A foreign body in the nose

may produce a blood stained nasal discharge which may simulate nasal diphtheria. Occasionally, too, the disease may arise in conjunction with a foreign body.

Laryngeal Diphtheria—This may be primary, but more often it is secondary to the faucial form. The symptoms are caused by mechanical obstruction of the glottis by membrane and inflammatory swelling. The condition is most liable to occur in children under five years of age. In infants the onset of obvious laryngeal obstruction may be rapid, in older children there is usually a phase of noisy breathing with a harsh "croupy" cough. *Inspiratory stridor* occurs. As the condition advances inspiratory embarrassment becomes urgent, the accessory muscles of respiration come into play, and there is recession of the lower ribs. Cyanosis, tachycardia, and restlessness are prominent symptoms. Any considerable degree of obstruction renders sleep impossible and the patient becomes rapidly exhausted. If no relief is afforded, death takes place from asphyxia.

Complications—The complications of diphtheria, with the exception of broncho pneumonia in the laryngeal form and the rare post-diphtheritic hemiplegia, are due to the effects of the toxin upon heart muscle and nervous tissues. Paralysis due to diphtheria may commence about the second or third week or be delayed considerably later. In the hypertoxic type cardiac failure and paralysis occur early.

Cardiac Involvement—Myocardial damage varies greatly in degree but is the commonest cause of death. "Early" cardiac failure may occur as the terminal phase of the initial generalised toxæmia. "Late" cardiac failure may occur at any time after the initial phase has passed, most commonly about the fifteenth day. It is characterised by *vomiting*, subnormal temperature, epigastric pain, no alteration in the character of the first heart sound, and enlargement of the liver. Heart block may occur at any stage and may be transient, it is especially common and serious in degree in late cardiac failure. Vomiting is a danger signal, death may follow in a few hours or a few days. In "convalescence" extra systoles may occur but in themselves are of no prognostic significance, as occasional heralds of more serious lesions they should be regarded with caution.

The following alone or in any combination are the commonest varieties of diphtheritic paralysis the pathogenesis of which is discussed on page 937.

Palatal—This is usually the earliest as well as the commonest, the signs are nasal voice, regurgitation of fluids

through the nose, loss or limitation of movement, and anaesthesia of the soft palate. The condition is usually bilateral.

Pharyngeal Paralysis—This is an extension of the palatal paralysis and is indicated by dysphagia, a characteristic "pharyngeal" cough, and the escape of saliva from the angles of the mouth.

Ocular—(a) *Extrinsic* strabismus is common, ptosis rare, (b) *intrinsic* paralysis of accommodation which is subjective and of short duration is relatively common, but in children, at least, often passes unnoticed, though adults may find themselves unable to read small print. The pupils continue to react to light, and frequently to accommodation also.

Intercostal Paralysis is shown by immobility of the costal walls during respiration, associated with increased respiratory excursions of the upper abdomen.

Diaphragmatic paralysis is the most fatal type. There is partial or complete immobility of the upper abdomen, together with increased respiratory excursions of the costal walls. The mortality from this type of paralysis is very high, if combined with intercostal paralysis the outlook is virtually hopeless. Paralysis of the diaphragm may be of short duration and it is occasionally possible, by the continuous administration of oxygen and artificial respiration, to tide the patient over the period of its duration. The use of some type of "breathing machine" has greatly improved the prognosis and has also shown that the condition may endure for as long as two weeks with ultimate recovery. Amongst the rarer forms of post diphtheritic paralysis are adductor and abductor laryngeal paralysis and pareses of various groups of muscles, e.g., facial.

A generalised peripheral neuritis involving the arms and legs may occur five weeks or so after the onset of diphtheria. It resembles other forms of peripheral neuritis and the outlook as regards complete recovery is favourable (vide p. 939).

Diagnosis—Early diagnosis followed by specific treatment is all important if life is to be saved. The majority of cases of diphtheria can and should be diagnosed upon clinical grounds. Valuable time may be lost if patients with suspected diphtheria be deprived of treatment pending bacteriological confirmation. Bacteriological investigations are important chiefly as an accessory or confirmatory procedure. The bacteriologist can report only upon the presence or absence of diphtheria bacilli, it is for the physician to make a diagnosis, to be confirmed later by the bacteriologist. It must be realised that the presence of diphtheria bacilli does not necessarily mean that the patient is suffering from diphtheria. In taking a swab care must be

exercised to see that it is rubbed firmly over the suspected area. Needless to say, in every case of true diphtheria virulent bacilli are present in the membrane, although not always recovered.

The differential diagnosis of tonsillar and pharyngeal diphtheria may be very difficult. Streptococcal tonsillitis may produce a membrane which closely resembles that of diphtheria but in the former condition there is, as a rule, a more obvious inflammatory condition of the throat. Vincent's angina produces ulceration, sometimes disguised by the overlying membrane. Patches of *thrush* in the mouths of infants should readily be distinguished. Its irregular distribution upon any part of the buccal mucous membrane, dead whiteness, easy removal, and the presence of the *monilia albicans* are the characteristic diagnostic points.

As already noted, laryngeal diphtheria is usually secondary to the faucial form and this fact is an aid to diagnosis. The condition is practically confined to infants and young children. It must be differentiated from *laryngismus stridulus* and the wheezing of *bronchial asthma*. Sometimes the severe catarrhal laryngitis occurring at the end of the prodromal stage of measles may produce considerable laryngeal obstruction. Scalding fluids and impacted foreign bodies produce obstruction suddenly. A history of the accident is usually obtainable. In infants, retropharyngeal abscess is a possible source of error. Among adults such conditions as hysteria, syphilis or tuberculosis are occasionally misdiagnosed as laryngeal diphtheria. The combination of laryngeal and bronchopneumonic diphtheria and the pressure of enlarged tracheobronchial glands and of neoplasms gives rise to stridor, which is both inspiratory and expiratory.

Treatment—The essentials of treatment consist in the administration of an adequate dose of antitoxin at the earliest possible moment and absolute rest in bed. The mechanical obstruction which occurs in laryngeal diphtheria may, in addition, necessitate relief by intubation or tracheotomy.

Antitoxin was first employed in England in 1895. Its use was attended by a dramatic fall in the case mortality from the disease, which immediately fell from 30 per cent or more to 20 per cent or less and has continued to show a progressive drop to the present level of 5 or 6 per cent. Other causes have contributed but the outstanding reason for the decline is without any doubt the increased employment of antitoxin in adequate doses. Its effects are seen in the alleviation of the toxæmia and in the cessation of the spread and the early separation of the membrane.

Whenever possible the highly refined globulin modified (protein digested) sera should be used. These products may contain 6,000 units or more of antitoxin in 1 c.c. Since they are virtually protein free serum reactions are rare.

Dosage—Dosage is based upon the extent and apparent age of the membrane and the indications of existing toxæmia. The dose for a child must *never* be smaller than that for an adult. Better results are obtained from a large initial dose than from repeated smaller ones. Too large a dose is hardly possible, too small a one easily so. Give antitoxin on *suspicion*. Beyond possible sensitisation, no harm can result if the suspicion prove ultimately to be unfounded. Never withhold antitoxin while membrane, however old, is still present. The following approximate scale of initial doses, increased later if necessary, will be found adequate except for the severely toxic case which requires intensive treatment —

Extent of membrane	(a)			(b)			(c)		
	One Tonsil			Both Tonsils			Both Tonsils with Pharynx or Larynx		
Age of membrane in hours	24	48	72	24	48	72	24	48	72
Antitoxin in 1 000 s of units	8	16	24	16	32	48	32	48	96

For primary nasal diphtheria 8,000 to 16 000 units and for primary laryngeal diphtheria 16,000 to 32,000 units are usually sufficient, toxæmia being but slight.

Route—Intramuscular injection into the outer side of the thigh is the best for routine practice. Absorption is too slow after subcutaneous injection. Intravenous injection of the whole or a portion of the dose is indicated if this exceeds 20 000 units. Provided that the serum is given *slowly at blood heat* administration being instantly stopped upon any sign of collapse it may be injected undiluted into the vein. The intraperitoneal route is an alternative in the case of young children with collapsed veins. Oral administration is absolutely useless.

In laryngeal diphtheria, unless the patient be obviously in need of surgical interference when first seen antitoxin should be given forthwith. A steam kettle is often used. Failure to improve within a reasonable time, increasing stridor and embarrassment of the right heart, and restlessness indicate

the necessity for mechanical suction through the direct laryngo scope, intubation or tracheotomy. The first two procedures are only suitable for hospital practice, the last is the method to be employed by the practitioner.

Once operation is decided upon, the sooner it is performed the better.

Absolute rest is essential. The patient should remain flat for a week and then be allowed a pillow a week up to three weeks, then after a week on a couch, walking may be begun cautiously. In toxic cases it is essential to give glucose, 20 gm in 50 cc of normal saline intravenously, if possible, and then 4 to 6 oz diluted in lemonade during each of the first ten days. If not tolerated by the mouth it must be given rectally. Careful watch must be kept upon the heart and for signs of paralysis. Palatal and pharyngeal paralysis may necessitate nasal feeding. Late cardiac failure is to be treated by raising the foot of the bed to obviate the occurrence of cerebral anoxia, a return to glucose, intravenously if possible or by the rectum and the injection of adrenalin. A minute dose of morphin ($\frac{1}{2}$ to $\frac{1}{4}$ gr) hypodermically is frequently of the utmost value in allaying the fatal restlessness and the distressing vomiting and epigastric pain of myocardial failure. Alcohol and strychnine are of doubtful value in diphtheria. Nikethamide (cornamine) is of more use. Digitalis tends itself to produce heart block.

The pulses usually clear up spontaneously, massage and electrical treatment for the arms and legs are seldom required.

Convalescence must not be hurried, and there must be a cautious return to school or occupation.

Mode of Spread and Prevention.—The carrier plays an important part in the spread of diphtheria. In industrial centres 5 per cent or more of the population harbour virulent diphtheria bacilli in the nose or throat, either temporarily or over longer periods. Such "healthy" carriers may be incubating the disease, may be or become immune, but are none the less carriers who may convey the specific organisms to others, especially in schools and dormitories.

After an attack of the disease the patient remains, for a varying period a "convalescent" carrier. Most patients undergo spontaneous bacteriological clearance by or before the time they are clinically fit for discharge. The carrier state is likely to be maintained by an unhealthy nasopharynx, and in such a case surgical measures afford the best means of securing bacteriological clearance. Before release of a patient from isolation it is usual to obtain two or three consecutive

negative swabbings from the nose and throat at intervals, preferably of a week. The organisms in the chronic carrier state should from time to time be submitted to a test for virulence. There is no justification for segregating a carrier of avirulent diphtheria bacilli.

The Schick Test discriminates between those who are susceptible and those who are not susceptible to an attack of clinical diphtheria, it is a test of *antitoxic immunity* not of *infection*. Diluted diphtheria toxin filtrate is used containing in 0.2 c.c. one fiftieth part of the minimum lethal dose (M.L.D.) for a guinea pig. This amount is injected intradermally into one forearm. A precisely similar amount of toxin filtrate, inactivated by heat, is injected into the other forearm. This acts as a control. If a control is not employed confusion may result because of the occurrence of pseudo-reactions due to sensitiveness to bacterial proteins. These are rare in children under eight years of age, but in older children and adults less rare.

The following readings of the test are possible: (a) *Negative* nothing is seen on either arm except the needle punctures. (b) *Positive* the test arm shows an oval or circular patch of erythema, which later pigments and desquamates, the control arm nothing. (c) *"Pseudo" (negative)* areas of erythema of identical appearance on both forearms disappearing in twenty-four to forty-eight hours. This is equivalent to a negative reaction. (d) *"Pseudo" plus positive* on both arms an area of erythema appears, but that upon the test arm is larger than that upon the control arm and presents an inner portion of deeper red. In twenty-four to forty-eight hours the control arm is clear and the "pseudo" element has disappeared from the test arm, leaving an ordinary positive test. The pseudo plus positive test is the most difficult of the four possible results to read correctly.

The Schick test properly carried out with reliable, recently diluted toxin, and correctly read, possesses a high degree of accuracy. The results of the test show that only about 15 per cent. of new born infants are susceptible to diphtheria, while the remaining 85 per cent. possess temporary immunity transmitted from the mother. Within six months of birth this transmitted immunity disappears, and the maximum percentage of positive Schick tests is found between the ages of six months and two years. Among adults the percentage of Schick positive reactions is lower than among children, and is usually about 30 per cent. The poorer the circumstances, and the more crowded the environment, the higher is the percentage of

negative reactors at all ages. This is due to the greater opportunities for the reception of small immunising doses of the infection.

Immunisation—The detection of a non-immune should be followed by his protection against the disease. Immunisation may be (i) *passive*, (ii) *active*, or (iii) *combined passive and active*, as recently employed.

(i) *Passive Immunisation* is an emergency measure suitable for immediate contacts. The injection of from 500 to 2 000 units of antitoxin quickly affords protection for a period of two or three weeks.

(ii) *Active Immunisation*, the procedure of choice, takes much longer to produce but has the advantage of enduring for at any rate some years. It should not be regarded as an emergency measure but as a regular procedure for the protection of susceptible children comparable to vaccination against smallpox. The importance of immunisation is greatest in the case of children of pre-school age but the procedure should also be adopted for all susceptible children of school age and also for adults such as hospital nurses who are specially exposed. Since most young children are Schick positive and therefore susceptible a preliminary test may be omitted in their case, but for older children and adults it should always be done, not only because many are already immune and so do not require artificial immunisation, but because the occurrence of a pseudo-positive reaction is an indication of sensitivity to the prophylactic (*vide infra*).

The prophylactics used in Great Britain are toxoid combined with alum—alum-precipitated toxoid (A.P.T.) and toxoid antitoxin floccules (T.A.F.) (toxoid is toxin treated with formalin and thus deprived of its toxic but not of its specific antigenic properties). Both are potent prophylactics, A.P.T. is usually employed for children under eight among whom it provokes but few reactions. T.A.F. is reserved for older children and adults since it rarely gives rise to reactions at any age. For pseudo-positive Schick reactors and those who have reacted strongly to a small preliminary dose of A.P.T., T.A.F. should be used. At least two doses of the prophylactic are necessary. Suitable doses of A.P.T. are 0.2 c.c. and 0.3 or 0.5 c.c. injected intramuscularly at an interval of four weeks, of T.A.F., three doses of 1 c.c. at intervals of not less than two weeks. As a check upon results, Schick tests should be done three months after the last dose. Positive reactors receive a further injection, and this is also advisable for young children attaining school age. No certificate of immunity

should be issued unless a recent Schick test is known to be negative

(iii) *Passive and Active Immunisation*—Clinical diphtheria has been treated successfully by a combination of antitoxin and toxoid the antigenic stimulus of the latter augmenting the antitoxic content of the blood Recently, combined active and passive immunisation has been advocated for the control of school outbreaks

MEASLES

(*Morbilli*)

Ætiology—Measles occurs all over the world and is endemic in large cities where, in alternate years, it assumes rapid and widespread epidemic prevalence Commencing in the late autumn, the height of the epidemic is usually attained during the first quarter of the year, by the end of the second quarter the epidemic ceases Among children under five and especially under three years of age, concomitant broncho pneumonia is the cause of many deaths, over the age of five this complication is much less common and much less fatal Infants under three months of age very rarely contract measles Since few reach adult life without having suffered an attack, with resulting active immunity, the mother, as a rule, confers placentally transmitted passive immunity upon the infant This immunity persists for the first three months of life It then wanes gradually and by the eighth month, or earlier, is at an end Thereafter, the infant is highly susceptible to measles

Bacteriology—The causal agent of measles is a filterable virus Common concomitant organisms to which the complications of the disease are due are the hæmolytic streptococcus the pneumococcus and the *B influenzae* of Pfeiffer

Pathology—There are no post-mortem changes characteristic of the disease The pathological appearances at autopsy are those due to the complications The chief of these, and the one most likely to kill, is broncho pneumonia

Incubation Period.—Ten to eleven days to the appearance of catarrhal symptoms, fourteen days to the rash

Clinical Description.—The prodromal stage of measles lasts for three or four days It is a febrile catarrhal period characterised by congestion of mucous membranes and the presence of Koplik's spots The signs and symptoms of this period are

grouped together as the *enanthem*. The period of the *enanthem* is followed by that of the *exanthem* or rash.

The child at first seems to have a cold with sneezing and running at the eyes and nose as prominent features, photophobia, epistaxis, and diarrhoea may occur. A few hours after the onset the temperature rises to between 99° – 100° F. Next day the catarrhal conditions persist and a short, hard cough develops. The temperature continues to rise, with slight remissions, up to perhaps 104° F., until the full development of the rash. Only when this begins to fade does the temperature drop either gradually or with some suddenness.

On examination of the buccal cavity during the prodromal stage, general reddening of the mucous membrane will be noted with perhaps a blotchy appearance of the soft palate. Most important, as being pathognomonic of the disease, is the presence of Koplik's spots.

Koplik's Spots.—These are to be detected in more than 90 per cent. of cases of measles examined in the prodromal stage. They may be present as long as five days before the appearance of the rash, and are thus not only of diagnostic but of prophylactic importance as their detection permits of the early segregation of the patient with the certainty that he has measles.

Koplik's spots are nearly always bilateral. They appear upon the buccal mucous membrane at the level of the premolar teeth and around the papilla of Stensen's duct (parotid duct). They must be sought for by gently retracting the angle of the mouth with a spatula and examining in oblique light, preferably daylight. Koplik's spots are made up of a central portion which has been likened to a grain of salt in appearance set upon an erythematous base. The spots may be few in number or so closely set as to give the mucous membrane of the affected area the 'matt' appearance of ground glass. They are detachable with difficulty. They have usually disappeared by the time that the rash is fully developed.

The Rash.—This first appears at the junction of the hair with the forehead and behind the ears. It spreads in regular order over the face, trunk and limbs, palms of the hands, and soles of the feet. The primary lesion is a macule or maculopapule the size of a lentil or smaller and of dull reddish colour. The individual macules as they appear soon coalesce into blotchy areas which frequently present a crescentic margin. The skin is normal between the blotches but these may become confluent over some portions of the body, giving the appearance of an erythema superficially resembling that of scarlet fever. The rash having attained its full development, which may take

twenty-four to thirty-six hours, gradually fades, leaving blotchy staining which is at first purplish and later brown in colour. This staining is usually most marked upon the abdomen. Desquamation of branny type occurs. Prodromal rashes of either scarlatiniform or morbilliform type are not infrequent and are irregular in distribution and fleeting in character. Measles may be confined to the prodromal stage, the rash never appearing, or the rash may abort. Haemorrhagic measles is fortunately rare, it is invariably fatal.

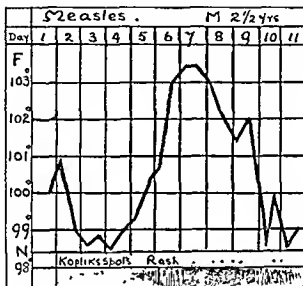


FIG 1.—Temperature Chart of an Uncomplicated Case of Measles in Child of 2½ Years Exposure to infection was eleven days before onset of symptoms

Complications.—The enanthem of measles affects the mucous membrane of the whole of the respiratory tract. A moderate degree of hoarseness at the height of the stage of enanthem is not unusual, and some degree of bronchitis may be regarded as a normal feature of the disease.

The chief complications of measles are as follows :—

1. *Catarrhal Laryngitis* so severe as to cause recession of the lower ribs may occur towards the end of the prodromal period. The condition, although it may appear alarming, commonly subsides as the rash develops. *Laryngeal diphtheria* as a secondary infection may occur at any stage of measles, and must be differentiated from the catarrhal form.

2. *Broncho-Pneumonia* is the chief and most fatal complication of measles, while *lobar pneumonia* is much less common. *Empyema* may follow either. Failure of the

temperature to fall after the full appearance of the rash should lead to a careful examination of the lungs and the ear-drums

4 *Enteritis* due possibly to infection of the bowel by *micropus* which has been swallowed, may occur in infants early or late and add to the gravity of the illness

5 *Ocular Complications*.—The conjunctivitis of the prodromal stage is commonly associated with photophobia. Phlyctenular conjunctivitis and corneal ulcers leaving opacities are not uncommon particularly in debilitated children as are blepharitis and styas

6 *Otitis Media*, occurring in the course of measles is one of the commonest causes of deafness or deaf-mutism in children. Careful watch for *mastoiditis* is essential

7 *Cancrum Oris* and *Noma* are the terms applied to a rapid gangrenous destruction of the tissues of the cheek and vulva respectively. The infection, which is similar to that causing Vincent's Angina (vide p. 92), rarely occurs except in neglected, debilitated children. Treated at once, the condition may respond to local applications of neoarsphenamine in glycerine. Later injections of this drug and excision of the affected tissue may be necessary

8 *Encephalitis* similar to that associated with other acute infections (vide p. 812) has occurred in some recent epidemics

Measles may be associated with whooping cough or diphtheria, less commonly with scarlet fever. Like whooping cough, measles may initiate pulmonary fibrosis or light up a latent tuberculous focus

Diagnosis.—In the catarrhal stage the detection of Koplik's spots clinches the diagnosis. These must not be confused with aphthous patches, or small ulcers of the buccal mucous membrane of dental or gastro-intestinal origin. The severe catarrhal laryngitis which may occur towards the end of the prodromal period is not uncommonly diagnosed as laryngeal diphtheria (vide p. 17). The rash of measles has to be distinguished from that of rubella and scarlet fever. The rash of scarlet fever does not occur on the face in punctate form, and the circumoral region is always spared. On the arms and legs however, it is sometimes coarse and almost blotchy, and may be confused with that of measles. In rubella the colour of the rash is distinctively pink (vide p. 30). Occasionally, a serum rash may have a morbilliform character but urticarial wheals are practically always to be seen upon some portion of the body. Certain drug rashes, notably that due to copaliba may

be confused. The *tongue* in measles may, on occasion, closely simulate the "strawberry tongue" of scarlet fever.

Treatment—Bed, an abundance of fresh air, an aperient, and light diet until the temperature has settled are the main requisites. The hygiene of the mouth, nose, and eyes is of great importance. If the cough proves troublesome, some simple sedative mixture is indicated. Complications must be treated as they arise. Sulphonamides are indicated for those due to secondary bacterial infections, these are due chiefly to hæmolytic streptococci.

Mode of Spread—With the exception of chickenpox and smallpox, measles is the most infective of the "fevers". The maximum degree of infectivity is present in the prodromal stage. At this stage measles may not only be conveyed by personal contact, but may be spread for short distances through the air, *e.g.*, from bed to bed. The buccal and nasal secretions are highly infective during the catarrhal period, but infectivity rapidly wanes after the appearance of the rash, and by the time that the latter has faded may be considered to have ceased. Articles freshly soiled by secretions in the early stages of the disease may transmit infection.

Prevention—Unfortunately, the prodromal stage of measles is rarely recognised except in institutional epidemics. When once the rash has appeared and the disease is recognised it is too late by the isolation of the first case to prevent others.

Since measles is very much less fatal to children over five years of age, any method which will postpone the almost inevitable attack until infancy has passed will result in the saving of many lives. The virus grown on chick-embryos, has been used for active immunisation upon a small scale with a measure of success. Injections of the *pooled* serum of convalescents or of adults who have had measles, *parental whole blood*, and *placental extract* (human immune globulin), although without specific therapeutic value, are successfully employed for either of two *prophylactic* measures—(a) *Sero-prevention* injected within the *first five days* after exposure, human serum, by conferring temporary passive immunity, prevents the attack in a high percentage of those exposed and injected, (b) *sero-attenuation* serum injected from the *sixth to ninth day* after exposure does not prevent but *modifies* the attack. Unless too highly modified permanent active immunity results from this modified attack.

Donors must be shown to be free from syphilis and their serum must be pooled and tested for sterility by the bacteriologist. Batches of pooled serum, especially adult

serum, vary widely in protective value. The donors must be young; serum derived from the elderly may have little value. In any case, and especially for prevention, adult serum is

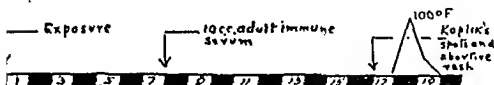


FIG. 2.—Diagram of Measles attenuated by Injection of Adult immune Serum. Note prolonged incubation period and attack of trifling severity, resulting in active immunity.

inferior to recent convalescent serum and should be injected in at least double the dose. Placental extract (immune globulin) has approximately the same value as adult serum and, if supplies of the latter are scanty, may replace it. Placental extract sometimes causes thermal reactions. For healthy children, attenuation is to be preferred; for others, prevention. The following scale of doses is suggested for children under five years of age:—

Serum.	Days after Exposure.		
	One to Five.		Six to Nine
	Prevention.	Attenuation.	Attenuation only
Convalescent . . .	5 c.c.	25 c.c.	5 c.c.
Adult Immune . . .	10 ..	50 ..	10 ..

The dose of placental extract is 2 c.c. for children up to two years of age. This dose is increased by 0.25 c.c. for each year of age up to a maximum of 4 c.c.

Parental whole blood may be withdrawn from either parent who may be immune and injected intramuscularly at once. The dose for attenuation in children under five is 30 c.c.; 15 c.c. into each buttock.

The disease is in its most highly infective period during the whole of the catarrhal period, and isolation commenced only when this period has passed is of greatly diminished value. A period of isolation of nine days, from four days before to five days after the appearance of the rash is sufficient. Exposed susceptible children should be kept under observation for

fourteen days, or seventeen days if serum prophylaxis has been employed, since attenuation may lengthen the incubation period

RUBELLA

(German Measles)

Ætiology.—Rubella is a disease of trifling severity and world wide distribution. In Great Britain it occurs in epidemic form in the spring and early summer. It affects children above the age of infancy and young adults. The causal organism is unknown. The disease is much less infective than measles.

Incubation Period.—From fourteen to nineteen days, occasionally twenty one days. Common periods are seventeen or eighteen days.

Clinical Description.—In children there may be no appreciable prodromal period, the appearance of the rash being the first indication of anything abnormal. Adults, however, may complain of headache, slight sore throat, general malaise, and stiffness of the neck for twenty four hours or so before the appearance of the rash. The prodromal period, if present, is always of short duration. Slight conjunctival injection may occur, and occasionally slight coryza and cough. Koplik's spots are not present. There may be a moderate rise of temperature to 101°-102° F which may persist for two or three days. There is an increase of Turch and plasma cells in the blood.

The rash, which sometimes produces itching, consists of pink macules ranging in size from a pin's head to a lentil and occasionally palpable to the finger, appears first, as a rule, upon the face, including the circumoral area, next upon the trunk, and last upon the limbs. This order is not invariable, it may be reversed. It is common for the rash to fade from the site at which it first appeared before erupting elsewhere. The macules may remain discrete or they may coalesce into blotches which lack the crescentic margins seen in measles. They may remain discrete in one area and become confluent or "scarlatiniform" in others. The rash is usually most typical upon the adductor aspect of the thigh and upon the dorsum of the foot. The colour of the rash, whatever its type and distribution, is neither the dull red of measles nor the bright red of scarlet fever, but definitely pink. By the second or third day after its appearance the rash fades. If it has been intense, faint

yellowish discolorations, quite different from the staining left by the measles rash, may be noted, these soon disappear. There may be scanty desquamation of "brunny" type. Palpable enlargement of the posterior cervical and sub occipital glands and sometimes of the axillary, epitrochlear and inguinal groups is common. Neuralgic and "rheumatic" pains and mild encephalitis have occurred as complications. Deaths ascribed to rubella are probably due to some concurrent condition.

Diagnosis—The diseases with which rubella is most likely to be confused are measles, scarlet fever, the roseolar rash of secondary syphilis and glandular fever (infective mononucleosis).

(a) *Measles*—The definite prodromal period of three to four days, the well marked coryza, conjunctivitis and the appearance of Koplik's spots during this period should serve to prevent confusion with rubella. The rash of measles is dull red in colour, as compared with the pink of rubella.

(b) *Scarlet Fever*—The scarlatiniform phase of rubella is constantly mistaken for mild scarlet fever. Points in favour of the latter are a sudden onset with sore throat and vomiting, tachycardia out of proportion to the pyrexia and the appearance twenty four to thirty-six hours after onset of the typical rash commencing at the neck and spreading in regular fashion downwards. If in doubt, the Schultze Charlton reaction should be performed (vide p. 12), and swabbings from the fauces plated on blood agar (vide p. 11).

(c) *Secondary Syphilis*—The history, other signs of secondary syphilis such as snail track ulcers on the fauces, alopecia, anamia, and the Wassermann reaction should prevent this very serious mistake. The rash of rubella appears first on the face, while in secondary syphilis the face escapes. The rash of rubella is sometimes irritating, the eruptions of secondary syphilis, on the other hand do not itch. Both conditions are associated with enlargement of groups of lymphatic glands.

(d) *Glandular Fever* is occasionally associated with a roseolar rash. The sub sternomastoid glands are those typically affected. They may attain the size of plums. In half the cases the spleen is palpable. There is no anemia. The blood picture shows characteristic monocytes.

Treatment—Bed, an aperient, and light diet for a few days constitute the only treatment necessary.

Prevention—Rubella, owing to its long incubation period and indefinite onset, may give rise to administrative difficulties in institutional outbreaks. Infectivity is of short duration. Isolation is only necessary until the rash has faded, five days.

are ample, as a rule. Concurrent disinfection of everything soiled by the patient is essential.

WHOOPIING COUGH

(*Pertussis*)

Ætiology—Whooping cough is now the most serious of the endemic specific infections of children living in large towns. This is due to (i) the high incidence among infants, although no age is exempt, (ii) the duration and debilitating character of the illness, and (iii) the liability, at any stage, to concomitant broncho pneumonia. (iv) the danger of permanent damage to the lungs. The disease is most prevalent in the early spring when broncho pneumonia is also rife, it tends to attain epidemicity every other year, sometimes concurrently with measles. The *Haemophilus pertussis* of Bordet Gengou occurs in abundance in the droplet spray expelled in the early stages of the attack, but is less easily recovered as the disease progresses.

Incubation Period—Seven to fourteen days to the catarrhal stage. The paroxysmal stage commences from seven to fourteen days later.

Clinical Description—Typically, the disease presents two stages. (i) a *febrile catarrhal stage* characterised mainly by pharyngitis and tracheitis due to the multiplication of the specific and associated organisms. After a week or ten days this stage merges into (ii) an *afebrile stage* of paroxysmal cough produced by the sensitisation of respiratory mucosa by a specific endoneurotoxin absorbed during the catarrhal stage. The catarrhal stage resembles a persistent common cold upon which is superimposed a harsh cough. The coughs are at first single, but soon become "grouped" and at length paroxysmal. The first paroxysm terminated by a "whoop" is usually heard at night. Vomiting after coughing is very suggestive of whooping cough before the whoop appears.

During an uncomplicated attack the paucity of pulmonary physical signs is throughout strikingly disproportionate to the severity of the cough. In infants and the aged the illness may be confined to the catarrhal stage or no typical whoop may occur. In infants paroxysmal sneezing may precede, follow, or replace entirely the paroxysmal cough.

The *paroxysm* may be divided into three stages. (i) a short

inspiration (not constant) (ii) a series of short sharp coughs which appear to gather speed and violence, and finally, (iii) a long drawn inspiration the sudden entry of air into the emptied lungs through a partially closed glottis gives rise to the characteristic whoop. The paroxysm is frequently succeeded by the vomiting of mucus and food particles. The number of paroxysms which are always more frequent at night, may vary from as many as fifty to as few as two or three in the twenty four hours, their frequency and completeness are indications of the severity and progress of the case. Although many weeks may elapse before they cease entirely, the paroxysms gradually become incomplete atypical and occasional. Some children retain the 'habit' of whooping long after they have ceased to be either ill or infectious.

A paroxysm may come on quite suddenly. Emotional excitement change of posture and particularly the swallowing of food, may suffice to bring on an attack. During the paroxysm which once started nothing avails to stop there is intense venous congestion of the face which assumes an almost bloated appearance with conjunctival suffusion and sometimes epistaxis. When the paroxysm ends the child rapidly recovers its ordinary appearance and its equanimity.

During the expiratory coughs the tongue is projected violently and repeatedly over the lower central incisor teeth. In this way the frenulum linguae at length becomes abraded, and in some cases an ulcer is produced.

Besides epistaxis, *subconjunctival hæmorrhages* are frequent. Less common is bleeding from the *membrana tympani*. Hæmoptysis and hæmatæmesis have been recorded.

Complications—The complications of whooping cough are more serious and dangerous than the disease itself. They are as follows—

Respiratory—Broncho pneumonia is common and frequently fatal in young children, lobar pneumonia is much less common. Empyema occasionally follows either. *Pneumothorax* of any type may occur.

Nervous—*Convulsions* may occur in infants and young children. The attack usually succeeds a paroxysm. Cerebral hæmorrhage may prove rapidly fatal.

Otitis Media as the result of secondary infection of the nasopharynx, may occur as in measles and scarlet fever.

Hernia and Prolapse—In the infant the violence of the paroxysms may give rise to hernia. Increase in the size of an existing umbilical hernia is common. Prolapse of the rectum may occur and be difficult to control.

By far the commonest and most important complications are broncho pneumonia and convulsions

Whooping cough and measles not uncommonly occur together Diphtheria, as a secondary infection supervening at any stage, naturally increases the gravity of the prognosis

Sequelæ—Some degree of emphysema may persist More important is the occurrence of fibrosis and bronchiectasis after broncho pneumonia or the possibility of activation of a latent focus of tuberculosis

Diagnosis—Clinical diagnosis in the catarrhal stage may be impossible A continued harsh cough which increases in frequency and severity from day to day, without adequate physical signs to account for it is suggestive particularly if followed by vomiting The following accessory procedures may afford assistance (i) *Cough plates*—Petri dishes containing a defibrinated preferably human blood medium, are exposed 4 or 5 inches from the child's mouth in order to collect spray (not sputum) during the act of coughing After incubation for three days the pearl like colonies of *H. pertussis* may be discerned (ii) *Blood-count*—During the early paroxysmal stage there is a high lymphocytosis (iii) The blood *sedimentation-rate* is retarded, in other infections the rate is accelerated

Gold and Bell suggest that a diagnostic triad of suspicious cough, lymphocytosis and a retarded sedimentation rate is peculiar to whooping cough Specific complement fixation and agglutination may be demonstrated in a high proportion of cases but only late in the disease *Skin tests* for specific allergy are quite unreliable

Before the cough becomes definitely paroxysmal it may be confused with ordinary bronchitis When the whoop is definitely established there can hardly be room for doubt

Treatment—The taking of food or drink may start a paroxysm followed by vomiting and thus the child may become undernourished Food must be given slowly in small quantities at a time If vomiting is troublesome it may be necessary to feed the patient immediately after a paroxysm as food is then usually retained

The treatment of whooping cough is unsatisfactory If injected in the earliest stages of catarrh, vaccines or endotoxins may mitigate the duration and severity of the attack, injected only in the paroxysmal stage these preparations are useless Some have claimed a measure of success for convalescent serum only, however if given very early

localising signs are apparent. Swelling of the parotid is first detected in that portion which lies between the posterior margin of the ramus of the mandible and the mastoid process. At first quite slight, and only appreciable to palpation, it rapidly increases. The resulting tension of the overlying tissues results in a characteristic uplifting of the lobe of the ear. Confirmation of the diagnosis of mumps may be afforded at an early stage by the appearance of papillitis at the orifice of Stensen's duct (parotid duct), by tenderness on pressure upwards and backwards behind the angle of the jaw, and by the occurrence of a lymphocytosis.

By the third or fourth day from the commencement of the process the whole of the gland, including the portion overlying the masseter, has reached the maximum degree of enlargement. Adjacent tissues become œdematous, the skin is stretched and may be slightly reddened. The disease may remain unilateral, but usually both glands are affected, successively or simultaneously. When the swelling is at its greatest, the patient experiences difficulty and pain upon attempting to open his mouth. Saliva, which at first dribbled from the corners of the mouth, becomes scanty, the mouth dry, and the tongue furred. The temperature may remain high for a week. The submaxillary and sublingual glands may be involved. During epidemics, cases have been detected where the process has been confined to one or other of these glands, the parotids escaping. Associated enlargement of neighbouring lymphatic glands is usually present. Albuminuria is frequent, deafness is a common complaint during the height of the swelling. The enlargement gradually subsides, and in about a week or ten days the parotids have returned to their normal size. Suppuration *never* occurs unless secondary infection has taken place.

Cerebral Mumps.—In some epidemics a number of cases have at the onset shown meningeal symptoms. In the meningeal reaction of mumps clinical signs of meningitis are not conclusive or complete. The cerebrospinal fluid is under pressure but quite clear, there is an excess of lymphocytes, the fluid is sterile on culture, Fehling's solution is reduced. Meningo-encephalitis may occur at any stage. The optic, facial, and auditory nerves may be involved. Occasionally optic atrophy and permanent nerve-deafness result.

Orchitis.—Mumps is peculiar in that metastatic involvement of other glands, notably the testes, may occur. In some epidemics orchitis is much commoner than in others. It usually occurs about a week or ten days after the initial

parotid swelling, and as a rule one testicle only is affected. Exceptionally orchitis occurs simultaneously with the parotitis and rarely it may be the first or even the only manifestation of the disease. Orchitis is rare before puberty, but common in adolescents and young men. Testicular pain and tenderness are very severe and constitutional disturbance considerable. Both the body and the epididymus may be affected, and atrophy may result. In girls, mastitis and rarely oophoritis may occur. Acute pancreatitis occurring a few days after the initial parotid swelling, or much later in convalescence, is uncommon but well recognised complication.

Diagnosis—In the presence of an epidemic of mumps the diagnosis can hardly be in doubt. The appearance of a fully developed case is unmistakable. Parotitis occasionally occurs in the course of other infections especially typhoid, and is usually suppurative. In Mikulicz's disease (*vide p. 387*) there is chronic symmetrical enlargement of all the salivary and lacrimal glands. Salivary calculus and tumours of the parotid may be easily excluded. An inexcusable error, which may be attended by disastrous results is to confuse the 'bull neck' of malignant diphtheria (*vide p. 16*) with mumps. One glance at the throat would serve to prevent such a disaster. The converse mistake is also made.

Treatment—Bed in a well aired room, a dose of calomel followed by a saline aperient, and a light diet in a form which can easily be swallowed are commonly all that are necessary. The hygiene of the mouth is important. For orchitis a suspensory bandage and applications of some soothing preparation such as glycerine of belladonna may be used.

Mode of Spread and Prevention—Mumps is conveyed by droplet infection, the disease is not highly infective. The patient must be isolated until swelling of the affected glands has subsided for a week. In practice this means an average period of isolation of two weeks from onset. Non-immune contacts should be kept under observation (*not in quarantine*) for at least three weeks from the date of the last known exposure. Concurrent disinfection of soiled handkerchiefs and utensils is important.

SMALLPOX

(Variola)

Smallpox occurs under all climatic conditions. The disease is endemic in parts of Northern Africa and in India. The

West Indies and South Africa are among the endemic foci of a milder type of the disease. Smallpox occurs in epidemic and, in the past, has occurred in pandemic form. The last pandemic in 1871-72, caused 40 000 deaths in the British Isles. In 1901-4 an epidemic resulted in some 4 000 deaths in England and Wales. Since that time the mortality from the disease has steadily fallen in this country, owing to a change in the clinical type. The disease shows seasonal prevalence. In countries of temperate climate it is a cold weather disease; fewest cases occur in the summer. L. Rogers holds that the prevalence of smallpox in endemic centres is dependent upon the absolute humidity of the atmosphere. Low absolute humidity favours while high checks the prevalence of the disease.

The causal agent is a filterable virus and occurs as the elementary bodies of Paschen in the vesicle fluid. Guarnieri's inclusion bodies are aggregations of these. The virus is identical with that of vaccinia (*vide p. 44*). Strains of the same virus of differing virulence give rise to clinical types of smallpox varying in severity. 'The viruses of vaccinia, alastrim (*vide infra*) and of a severe case of confluent smallpox all agglutinate specifically to anti-vaccina serum both in the complement fixation and in the agglutination test' (Mervyn Gordon). There are two chief strains of the virus: (a) Eastern causing smallpox of the classical type (*variola major*); (b) Western, derived from the United States or from the West Indies, causing cases of a mild or relatively mild type (*variola minor* or 'alastrim'). This form occurred in England and Wales in 1922. After several years of prevalence *variola minor* has temporarily died out in the British Isles.

Before vaccination was available smallpox was a disease of children. 90 per cent. of the deaths occurring in those under five years of age. In 1926 out of a total of more than 10 000 cases only 8 vaccinated persons contracted the disease under fifteen years of age, whereas 4 840 unvaccinated persons contracted the disease under that age. In the same year the case mortality of this mild type was only 0.15 per cent. In the 1901-4 outbreak of *variola major* the mortality ranged from 6 to 30 per cent. for all cases.

Pathology — Apart from the cutaneous lesions nothing characteristic is to be seen at autopsy. Myocardial degeneration is marked as it is in death from other toxic processes. The spleen is enlarged and soft. Signs of fatty degeneration may be present in the liver and kidneys. The lungs frequently show evidence of broncho-pneumonia.

Incubation Period.—This is very constant in *variola major*: twelve days to the onset of the prodromal stage, fourteen days to the first appearance of the eruption.

Clinical Description.—(a) *Variola major*. The prodromal stage of smallpox lasts for two or sometimes three days. The onset is usually, but not always, abrupt. Headache, vomiting, severe pain in the back and limbs, shivering, and marked pyrexia are common at the onset. Relaxation of muscular tone occurs, particularly well seen in a characteristic fatigued expression of the face. Delirium may occur. The temperature steadily rises and may attain to 104° or 105° F. by the end of the second or third day. *Prodromal rashes* sometimes appear and may be petechial, erythematous, or urticarial. The petechial type, always indicative of a severe attack, invariably appears in the flexures of the groins, extending upwards as far as the umbilicus, and downwards to some two inches below Poupart's ligament. The rash is most dense over this area, although it may extend up the flanks towards the axillæ. Being petechial, it persists for some days after the appearance of the eruption proper. The other prodromal rashes appear earlier than the petechial forms. Although characteristically patchy and fleeting, these rashes usually invade the "batling drawers" area, and may persist until the eruption of papules, and then fade.

Stage of Eruption.—1. *Papular Stage.*—The eruption commences to appear as a rule upon the third day. It takes two, three, or sometimes four days to complete its evolution. The lesions are at first tiny macules, which soon become papules, set deep in the skin and surrounded by an areola. The focal lesions of smallpox appear in a definite manner, which it is of the highest importance to observe in order that a correct diagnosis may become reasonably certain. Not only do the lesions appear in a definite order, but they attain a definite distribution and relative density following certain well-defined laws which were worked out by Ricketts.

In point of *time of appearance* the lesions appear in the skin in the following order: forehead, face and scalp; wrists and the backs of the hands; trunk, chest, back, and abdomen; legs and feet. They may also appear in the buccal cavity, especially on the soft palate, on the tracheo-bronchial mucous membranes, including the larynx, and occasionally upon the conjunctiva.

In point of *density* the following distribution is observed. In the first place, the lesions of smallpox tend to occur profusely upon any sites which have been irritated during the period of

incubation or which have been subjected to pressure, they appear most profusely upon exposed parts and upon convexities. In the fully erupted papular stage the lesions are distributed centrifugally in the following order of *decreasing* density, (i) the face, (ii) the wrists and backs of the hands, (iii) the forearms, (iv) the back, (v) the feet and the extensor aspects generally. The lesions occur much more sparsely upon areas of the skin which are normally protected, such as the chest and abdomen, the inner aspects of the thigh, the groins and the axilla. So regularly is the axilla free or relatively free from the eruption in smallpox that Ricketts termed the phenomenon "the sign of the axilla."

When the eruption of papules is complete, the temperature usually falls and the patient expresses himself as feeling much better. The rise of temperature in the prodromal stage is due to toxæmia which does not always entirely disappear with the completion of the papular stage, but commonly does so.

2 *Vesicular Stage*—Gradually the papules become converted into vesicles, associated with this change is an increase in the area and brightness of the areola which surrounds each lesion. The vesiculation of the papules is completed in two days as a rule. The apex of some of the vesicles may show "umbilication." If the wall of a vesicle be punctured with a needle it does not collapse, owing to the multilocular character of the vesicle. For some twenty-four hours the contents of the vesicles remain clear, they then become opalescent, this is the beginning of the pustular stage.

3 *Pustular Stage*—With the commencement of pustulation, the temperature, which has remained low since the completion of the eruption of papules, again begins to rise, and continues to do so until the stage of pustulation is complete. This secondary rise is due to septic absorption. The stage of pustulation takes four or five days to complete. The lesions swell up and assume a tense hemispherical appearance, the areola fades and disappears. Upon the face, where the rash is most profuse, this swelling and associated œdema of the tissues results in what may amount to obliteration of the ordinary features and the patient becomes unrecognisable. The constitutional symptoms return with great severity.

4 *Stage of Desiccation*—The pustules gradually shrink and dry up, forming crusts or scabs which ultimately separate, leaving characteristic deep set pools. This stage is of variable duration. The separation of the scabs, and particularly of the "seeds" upon the palms and soles, may take three, four, or more weeks.

(b) *Variola minor* (alastrim) varies widely in clinical severity. Cases have occurred indistinguishable in any respect from a severe attack of classical smallpox. On the other hand, "influenza with spots" has not inaptly described most cases. Even in the unvaccinated, the prodromal illness may be trifling and the lesions very sparse. Mortality in either vaccinated or unvaccinated patients is very low. There is a tendency to

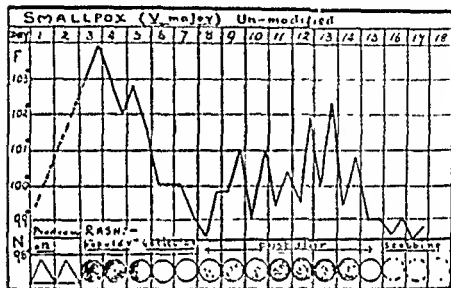


FIG. 3.—Temperature Chart of Smallpox in an Unvaccinated Patient aged 49

prolongation of the incubation period which may extend to fifteen days to the onset of prodromal symptoms. The latter although usually slight may be severe, and in any case form no guide to the probable profusion of the eruption. Prodromal rashes are rare and, when they occur, erythematous. The distribution of the eruption is identical with that of ordinary smallpox. The more leisurely eruption of the papules, which may appear upon the face twenty-four hours earlier than upon the extremities, the more rapid maturation of the lesions, which may be unilocular, and the marked tendency to abort at any stage give a deceptive appearance of "cropping" which has led to confusion with chickenpox. Secondary fever is slight or absent and the incidence of complications is low. In the unvaccinated, smallpox occurs in *unmodified* form, but the attack becomes *modified* as the result of previous successful vaccination.

Modified smallpox (*varioid*) is clinically indistinguishable from *variola minor*. In the former, modification results from

partial immunity to a virulent strain in the other it is due to a degraded virus (Marsden)

A further classification into *discrete* and *confluent* smallpox refers to the closeness with which the lesions are set upon the face

Hæmorrhagic smallpox is characterised by the extreme severity of the prodromal toxæmia, the occurrence of petechial prodromal rashes and of generalised erythematous rashes. Rarely death may occur from toxæmia either before the appearance of the papules or as they are appearing. The papules are poorly formed and velvety to the touch. Hæmorrhages from mucous membranes occur.

Complications—The important complications are the following—

(a) *Cardiac*—Myocardial failure may occur at any stage but most commonly during the phase of pustulation.

(b) *Respiratory*—Lesions occurring in the larynx may occasion œdema of the glottis. Some bronchitis is usual and broncho pneumonia is common.

(c) *Nervous*—Transient toxic encephalitis may complicate the prodromal stage. Encephalo myelitis pathologically identical with post vaccinal encephalitis (*infra*) may occur from five to thirteen days after the appearance of the focal rash. Peripheral neuritis and psychoses e.g. melancholia are occasional sequelæ.

(d) *Special Senses*—Some degree of conjunctivitis occurs in most severe cases. Keratitis followed by ulceration and rapid destruction of the globe with sympathetic ophthalmia of the other eye may result in complete blindness. Otitis media is not uncommon.

Albuminuria is constant and suppression of urine may result in uræmia. Orchitis is an occasional complication in severe cases and produces areas of necrosis in the body of the testicle. Boils are common and may be very troublesome.

Diagnosis—1 *Prodromal Stage*—Influenza is the condition most commonly confused. Other conditions causing malaise vomiting pyrexia and more or less localised pain are pneumonia and acute appendicitis. The following diseases have been diagnosed as the prodromal stage of smallpox: cerebro spinal fever, heat stroke, typhus, relapsing fever, plague and malaria.

2 *Eruptive Stage*—The characteristic centrifugal distribution may be confirmed by an actual count of the lesions present upon the proximal and distal portions of a limb or of the eyebrow line drawn at the level of the nostrils compared with those

upon ordinary lines. In the case of keratitis with perforating ulcer, prompt excision of the globe may become necessary in order to prevent sympathetic ophthalmia. Sulphonamides have been used with success to mitigate the severity of the pustular stage.

Mode of Spread, and Prevention—The virus is conveyed in the secretions of the mouth and nose, and also persists in moist scabs. The disease may be spread through the air for short distances. The administrative control of the disease is based upon the view that aerial convection may occur. Although both are disseminated with equal readiness the strain causal of *V. major* being highly virulent, is effective in smaller doses than the degraded strain causal of *V. minor*, with the practical result that *V. minor* is less infectious. Patients must be isolated in a hospital set apart for that disease from the time of diagnosis until the scabs have completely separated to leave healed cicatrices. All known contacts must be vaccinated or, if they refuse, be kept under observation (not necessarily in quarantine) for sixteen days. Vaccination and re-vaccination is the real method of prevention.

VACCINIA AND VACCINATION

In 1796 Edward Jenner of Gloucester introduced the process of *vaccination*. He noted that inoculation of human beings with the virus of cowpox "vaccination," produced a localised process which was protective against smallpox. All subsequent evidence is in favour of Jenner's belief. The virus of vaccinia is nothing else than that of variola modified in its virulence for man but not in its immunising action against variola by passage through the cow" (Mervyn Gordon).

The gradual extension of vaccination during the nineteenth century resulted not only in a decline in the mortality from smallpox at all ages but in a virtual reversal of the age incidence. Instead of being predominantly a disease of childhood its maximum incidence and mortality fell upon unvaccinated or imperfectly vaccinated adults. Due in part to the facilities provided for "conscientious objection" and in part to the prevalence of a mild type of the disease during recent years, vaccination with its occasional sequel of encephalitis has declined in Great Britain. The introduction and spread of classical smallpox (*V. major*) amongst a largely unvaccinated or imperfectly vaccinated population is thus liable to have deplorable results.

Prior to the Vaccination Order of 1929, with a view to securing immunity to smallpox of maximum duration, it was advised that four insertions of calf lymph should be made in order to secure a total area of vesiculation of not less than half a square inch. While four insertions are still permissible and desirable if effective immunity for not less than seven years be desired, Public Vaccinators are now directed to make a single linear insertion with a minimum of trauma in order to reduce as far as possible local and constitutional effects and the likelihood of nervous sequelæ. Scarification and cross hatching are to be deprecated.

Technique—(a) Glycerinated calf lymph contained in capillary tubes is used. It must be stored in an ice chest until required and used within a week of receipt. Excellent results have been obtained from the use of a bacteria free vaccine produced by growing the virus upon chiel embryo membranes, thus obviating the use of non-sterile lymph. (b) *Site*—The left deltoid region or the inner side of the arm just above the internal condyle (Goldberger's method). (c) *Preparation*—The skin is washed with soap and water and allowed to dry. No non-volatile anti-septic must be used. (d) *Insertion*—The ends of the capillary tube are broken and an ejector attached. One drop of lymph (for each insertion) is blown out on to the skin. With a round bodied sharp pointed sewing needle sterilised and cooled a superficial scratch is made without drawing blood through the drop of lymph. The length of the scratch should be $\frac{1}{2}$ of an inch but must not exceed $\frac{3}{4}$ of an inch. (e) *Dressing*—The insertion is allowed to dry thoroughly. An antiseptic dressing is then applied. (f) *Inspection*—The arm should be inspected on the seventh or eighth day and again on the fourteenth or fifteenth day. Other methods of insertion by multiple punctures or ultra-dermally are preferred by some. The above is the usual "standard" technique.

The course of a successful primary vaccination is as follows: (1) there is an incubation period of *three days*, during which itching and irritation are common, (2) on the fourth day a papule appears at each insertion, (3) on the fifth day the papule becomes a vesicle surrounded by an areola, and the vesicle during the ensuing twenty-four hours shows umbilication, (4) during the seventh and eighth days the vesicle becomes opalescent, the areola increases in intensity, and there is much infiltration of the whole site, (5) from the eighth to the tenth day definite pustulation of each lesion occurs, with an associated enlargement of the axillary glands. The arm

may become quite "brawny," as in cellubtis. Constitutional symptoms, of varying severity, are met with. Transient splenomegaly occurs in a proportion of cases. From the tenth day onwards the pustules gradually dry up to form scabs, which ultimately separate, leaving scars at first pink, but later white and exhibiting pitting or *foveation*. This *foveated* scar is the essential sign of a successful vaccination.

Revaccination—Unless a very long period has elapsed since the primary operation, the local and general signs and symptoms which follow a revaccination are usually considerably modified. The lesions may abort at any stage. Revaccination should be carried out every seven years, or even more frequently in the case of persons living in countries where smallpox is endemic.

Generalised Vaccinia very occasionally occurs. It is characterised by the eruption of papules upon the body at any time during the phase of activity of the local lesions, i.e., from the fourth to the tenth day. The papules appear in crops and go through the stages of vesiculation and pustulation.

The appearance of lesions elsewhere than upon the arm may be due to the accidental transference of lymph by the patient, after scratching the arm, into an abrasion upon the face or elsewhere.

Complications—These are usually due to sepsis introduced by the patient as the result of scratching. Erysipelas may occur in this way. Infection with syphilis or tubercle is an absolute impossibility as the result of vaccination with calf lymph, but it was possible in the old days of arm to arm vaccination, which is now never employed.

Post Vaccinal Encephalitis—The rare occurrence of encephalitis or meningo encephalitis following vaccination has been recorded in recent years. The symptoms and histological lesions appear to be identical with those of encephalitis associated with other of the acute viral infections e.g. measles. Practically all the recorded cases have occurred following primary vaccination in children of *school age*. Cure has followed the injection of serum derived from a person recently vaccinated with lymph from the same batch. Simultaneous injection of parental whole blood has been practised.

Duration of Immunity—The duration of immunity is directly proportional to the area of true foveated scarring. When the area of scarring measures not less than half a square inch, immunity may be relied upon for seven years and probably for ten. No information is yet available as to the duration of immunity procured by the single insertion method. The intervals at which revaccination is advised have been stated

INFECTIOUS DISEASES

the buccal cavity, but the lesions here are so delicate that they readily rupture and may not be recognisable. They may occur within the larynx and upon the conjunctiva. Upon the skin they first appear upon the back, chest, and abdomen—particularly the lower abdomen—and the adductor aspects of the thighs. The face and hairy scalp are next invaded. The arms and legs, including sometimes the palms and soles, are usually the last to present lesions.

The distribution as a whole is centripetal, being most abundant upon the trunk. The numbers of lesions upon the upper arms exceed those upon the forearms, the numbers upon the thighs those upon the legs. The lesions of chickenpox in contrast to smallpox tend to invade concavities and protected surfaces such as the axilla.

Herpes and Varicella—The virus of chickenpox, ordinarily dermatotropic, occasionally assumes neurotropic properties resulting in the clinical manifestations of herpes zoster. This is not to say that herpes zoster is invariably due to the virus of chickenpox.

The exceptional occurrence of *encephalitis* provides further evidence of the neurotropic affinities of the virus.

Complications—The occasional occurrence of vesicles within the larynx has been noted. Very rarely this localisation has necessitated tracheotomy. Lesions upon the conjunctiva being quite superficial, rarely give rise to trouble. In debilitated children the lesions may ulcerate or become gangrenous. *Varicella gangrenosa* may be caused by the infection of the lesions with hæmolytic streptococci or virulent diphtheria bacilli, giving rise to early fulminating and late subacute forms respectively. Diphtheria and scarlet fever antitoxins and sulphonamides should be given as soon as possible in all cases of *V. gangrenosa*.

Diagnosis—If the points noted under clinical description are carefully compared with the description of smallpox, confusion between the diagnosis of the two diseases should not arise. The prodromal scarlatiniform rash is sometimes diagnosed as scarlet fever. Papular urticaria, the lesions of which never appear in the mouth, scabies, and impetigo have also to be excluded.

Treatment—Bed and light diet for a few days are desirable. It is important to prevent undue scarring either as the result of scratching the lesions or of secondary impetigo. Small doses of the sulphonamides, given early in the attack, may reduce the severity of pustulation. Separation of the scabs is facilitated by treating each with carbolic oil applied gently with a feather.

Mode of Spread and Prevention.—The disease is most infective in its earliest stages. Infectivity wanes rapidly after the full appearance of the eruption, but isolation should be maintained until all the scabs have separated. Infection is commonly conveyed from person to person, in the early stages the virus is readily carried upon the hands of a third person who has been in attendance. There is some evidence that in its early and most infective phase chickenpox may be spread for short distances as from bed to bed through the air. Prevention consists in the earliest possible isolation of cases concurrent and terminal disinfection and an observation period of 21 days for exposed non-immune children.

TYPHOID AND PARATYPHOID FEVERS

(Enteric Fever)

Ætiology.—Typhoid and paratyphoid fevers (A, B, and C), the diseases which comprise the "enteric group," occur all over the world and affect all races. Of the paratyphoids B is more common in England, in the East, A is more frequently encountered, C is of exceptional occurrence. The prevalence or otherwise of enteric fever in any country, district, or town is an index of the general standard of sanitation, particularly in relation to the water supply. In this country the number of notifications of enteric fever varies considerably in individual years, e.g., 1,200 in 1931 and 2,500 in 1936. These figures are small compared with those obtaining in the past, even as recently as 1911 there were some 13,800 notifications. "There is a tendency in recent years to a low level of diffusion over the whole country, suggesting that the major causes such as polluted water supplies and urban environment are gradually being eliminated and there now remain the more elusive and less easily controlled factors such as carriers, contact infection, contaminated shell fish and other foods" (G. Newman).

Localised epidemics occur from time to time and an increase in the notifications in any year may be due, almost entirely, to a single outbreak. In the case of typhoid especially, inquiries into an outbreak should first be directed to the water supply, next to milk and then to shell fish (oysters and mussels) and watercress. Epidemics of paratyphoid, more frequently perhaps than those of typhoid, have been traced to a carrier who in

institutional outbreaks may be discovered among the kitchen staff. Infection with bacilli of the enteric group may be indirect, through articles of food or drink, whether these have been infected through the medium of sewage, flies, or carriers or direct, as happens when a nurse infects herself with the dejecta of a case of the disease.

Carriers—Persons who have had a recognised or unrecognised attack of the disease may continue to excrete organisms in the *fæces*, usually intermittently, for many years. The bacilli persist in the gall bladder and pass thence into the intestine. Biliary carriers are usually women and having regard to their closer association with the preparation of food are the more dangerous. Urinary carriers also occur. This condition responds to the sulphonamides whereas biliary carriers may require cholecystectomy if the sulphonamides prove unsuccessful after adequate trial.

Enteric fever shows distinct seasonal incidence. In Great Britain prevalence commences in September and attains its maximum in October and November, fewest cases occur in the spring. In warm climates the greatest number of cases occur during the hot weather.

All ages are liable to attack by infections of the enteric group, but the period from ten to thirty five provides the greatest number of cases.

The fatality rate from typhoid varies from 10 to 20 per cent. for the paratyphoids it ranges from 1 to 9 per cent.

Bacteriology—The typhoid paratyphoid bacilli belong to the *Salmonella* group and have the following characteristics: they are motile and with suitable staining can be shown to possess flagella. They are gram negative and in culture they do not ferment lactose. Differentiation between the various types depends on cultural and agglutination reactions. The bacilli occur in the blood in the early stages particularly in the rose spots, the *fæces*, urine and internal organs, especially the spleen and gall bladder.

Pathology—Except that the intestinal lesions caused by the paratyphoid bacilli are as a rule less severe than those due to *Bact. typhi*, and that in paratyphoid infections the large bowel shows ulceration more commonly than in typhoid, the pathology of the conditions is virtually the same. The typical lesions occur in Peyer's patches, which undergo progressive inflammatory changes resulting in ulceration and sloughing. The detachment of the slough may cause either hæmorrhage or perforation of the bowel but the usual process is granulation and healing. The ulcers which occur are elliptical with their

long axes in line with the length of the intestine, the edges are undermined and the bases clean, there is associated enlargement of mesenteric glands. The spleen is enlarged and friable and teems with the specific organism. The liver shows degenerative changes. The heart muscle is markedly flabby. Patches of Zenker's degeneration may affect the large muscles. Suppurative arthritis and abscesses in the long bones occur, from either of which the specific organisms may be recovered. The so called "typhoid spine" is a periostitis of the bodies of the vertebra with associated changes in the intervertebral discs.

Blood Picture—Typically, leucopenia with eosinopenia occurs after the first few days, and may be an important accessory factor in diagnosis in the absence of bacteriological or serological facilities. Complications or secondary infections during the course of the disease give rise unless the patient's condition be very grave, to a polymorphonuclear leucocytosis.

Incubation Period—In both typhoid and the paratyphoids the incubation period is variable, that of typhoid varies from twelve to sixteen days, but exceptionally long periods exceeding twenty days are on record. The paratyphoids have even more variable incubation periods, ranging from five to fifteen days.

Clinical Description—Typhoid and the paratyphoids possess marked clinical similarity, but show certain more or less characteristic differences.

Typhoid—The onset is usually insidious, so insidious in some cases (ambulant forms) that the patient may walk about for days while actually suffering from the disease, until he is incapacitated by the gradual advance of the infection, or overtaken by some sudden calamity such as a haemorrhage or myocardial failure. In those who have undergone protective inoculation, but in whom immunity has to a great extent waned with the lapse of time, the disease may be mild or abortive. Such mild types also occur in children.

Typhoid fever of average severity shows three fairly well marked stages—

First Stage—This period is characterised by gradually advancing general malaise and a desire for sleep although sleep is disturbed. There is headache, which is usually frontal and often extremely severe, giddiness, pain in the limbs, and sometimes in the right iliac fossa, anorexia and thirst, nausea and vomiting, which, however, are relatively uncommon. The tongue is dry and furred and the bowels are usually constipated at the onset. Lymphatics are not uncommon.

During the period of invasion, which lasts from five to seven days, the temperature rises by about a degree each evening, until by the end of the first week it has usually attained 103° 104° F. The temperature chart in enteric is often described as having a step ladder character during the first week.

Second Stage—By the end of the first week the general symptoms have advanced and the patient presents a characteristic appearance. Markedly prostrated, he is inert and may be stuporose. muttering delirium may be present, particularly at night. he has lost flesh. the tongue is dry and

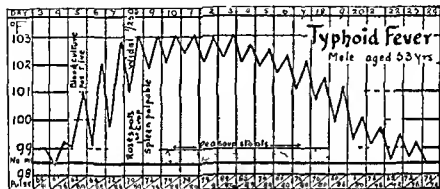


FIG. 4.—Temperature Chart of Typhoid Fever

brown and there are sordes around the lips. the abdomen is distended. The pulso is now soft, tends to be slow in proportion to the temperature and is often dicrotic.

At the end of the first week the eruption of 'typhoid spots' occurs. These are discrete lenticular erythematous rose spots which usually are seen upon the upper abdomen and upon the back. In number they may be confined to half a dozen and require careful search. The most important characteristic of the 'rose spot' of typhoid is its transitory nature: an individual spot is seldom visible for much over forty-eight hours after which time it fades. Fresh crops of spots may continue to appear for as long as several weeks. If in a suspected case of enteric doubtful spots be seen, they should be ringed round with indelible pencil so that at a later visit their presence or absence may be confirmed. By the end of the first week also the spleen has often become palpable. The typhoid patient may remain constipated throughout, but usually initial constipation is succeeded during the second week by diarrhoea. The stools in typhoid are typical—the so called pea soup stools. They are liquid and of a pale yellow colour,

Second Attacks may occur at an interval of years after the first, but are rare

PARATYPHOID—Apart from the somewhat shorter incubation period, the paratyphoids show certain other differences. It is impossible to discriminate clinically between paratyphoids A, B, and C. The paratyphoids may have a gradual onset like typhoid, but usually it is much more abrupt. Particularly in para B a gastro intestinal type of onset may occur, with a sudden attack of colicky abdominal pain, diarrhoea, and vomiting. There is intense headache, which may continue throughout the attack, and early prostration. The temperature rises rapidly to 101° F, but pyrexia in the paratyphoids, especially in para B, is of shorter duration than in typhoid. In para B the attack may be of only a week or ten days' duration, or may extend to eighteen days, in para A the typical attack extends over three weeks. In both, the temperature chart exhibits a "spiky" character, the pyrexia showing a range of some two degrees between morning and evening temperature. Bradycardia is more common than in typhoid. The rash in the paratyphoids appears in crops, and is characteristically much more abundant, especially in para A, than in typhoid. It may invade the face. The spots are also larger and of a deeper colour, in para B they may be papular. Constipation is common in the paratyphoids. Para C may resemble the ordinary paratyphoid, the onset may be of the gastro intestinal type, but acute septicæmic, bronchitic, and pneumonic forms have been recorded.

Types of Enteric Fever—Typhoid, and much more rarely paratyphoid, may occur in a fulminating, hyperpyrexial form, death taking place from toxæmia in a few days. Hæmorrhagic typhoid is very rare and is almost invariably fatal.

Typhoid or paratyphoid may commence with meningism or with true acute meningitis, the specific organisms, in the latter case, being recoverable from the cerebrospinal fluid. In infants and young children the onset of enteric fever is frequently abrupt and may simulate the "acute abdomen". Particularly in paratyphoid B, meningitis, gastro enteritis or broncho pneumonia may dominate the clinical picture in the early stages.

Complications—These are numerous. Any of them may occur in both typhoid and the paratyphoids, although they are, upon the whole, much more likely to do so in the case of typhoid fever.

The major complications are most liable to occur from the end of the second to the end of the third or beginning of the fourth week. The two gravest of these are hæmorrhage and

perforation caused by the separation of the sloughs from ulcerated Peyer's patches. In the process of separation a vessel may become eroded, or a tear occur through the tissue remaining at the base of the ulcer and through the peritoneal covering of the bowel. *Mycocarditis*, which is usually marked during the third week, is the result of toxæmia. *Lobar pneumonia* whether it occurs, as it may do at the onset or, more usual during the third week, is due to a secondary pneumococcal infection although typhoid bacilli may be present in the sputum. *Broncho pneumonia* is not an infrequent terminal event superimposed upon hypostatic congestion.

Hæmorrhage, perforation and myocarditis must be further discussed.

Hæmorrhage—Small streaks of blood may be observed in the stools during the first week, as the result of the hyperæmic condition of Peyer's patches. They are of no importance. At any time after the end of the second week and particularly at the end of the third week hæmorrhages of considerable magnitude may occur quite suddenly. The patient complains of faintness and of abdominal discomfort rather than pain. He becomes pale and sweat may appear upon the forehead. He may be restless with sighing respirations, and vomiting sometimes occurs. The pulse becomes thready, rapid and running and the temperature falls to subnormal. The blood passed per rectum may be bright red or dark, depending on the length of time it has remained in the intestine. Hæmorrhage may be single or repeated.

Perforation—Perforation may be associated with or follow hæmorrhage, or it may occur independently. Though usually single perforations may be multiple. The most common site for their occurrence is from 1 to 2 ft. from the ileo-cæcal valve. Although perforation is usually a complication of a severe attack or one which has shown recrudescence it may also occur in a mild attack. The majority of perforations occur at the end of the third week. The patient suddenly complains of acute pain in the lower abdomen particularly in the right iliac fossa. The facial expression becomes anxious and drawn; there may be beads of sweat upon the forehead. The pulse and respirations increase and the temperature may show sudden drop though this is by no means invariable. A rigour sometimes takes place. Vomiting at this stage is uncommon. There is great tenderness upon palpation of the lower abdomen and the abdominal muscles are on guard. These are the early symptoms and signs of perforation. Later, signs of general peritonitis appear. Disappearance of the liver dullness which

used to be described as one of the cardinal signs of perforation, is both inconstant and late. To await it is seriously to diminish the patient's already slender chance of recovery.

Myocarditis—Although cardiac involvement may manifest itself at any stage it is particularly liable to do so during the third week. The signs and symptoms do not differ from those of myocarditis due to any other cause.

Many other complications are occasionally encountered. Perhaps the most frequent is *phlebitis* of the left femoral vein, which leads to a femoral thrombosis during the later stages of typhoid or in early convalescence. Rarer complications are the following: pericarditis and endocarditis, cholecystitis, ulcerative laryngitis. *Parotitis* which is usually suppurative, and *orchitis* are not very uncommon. *Appendicitis* with which perforation may be confused, is an occasional complication. *Otitis media*, *osteitis* of the long bones with abscess formation, *myositis*, resulting in rupture and ecchymoses due to hæmorrhages are all complications which occur in the later stages or during convalescence. *Spondylitis* ('Typhoid Spine') has already been mentioned (*vide p. 51*).

Associated Diseases—Double infections of typhoid and paratyphoid occur. In the tropics the water which has caused typhoid may also contain the organisms of other water borne diseases and these may occur together with typhoid, or rather, since the incubation periods are shorter, precede it in the same patient. Double infections of cholera and typhoid, and bacillary or amoebic dysentery and typhoid are not uncommon. Attacks of malaria or relapsing fever during the course of typhoid are sometimes encountered. Diphtheria is not uncommon in association with typhoid or paratyphoid.

Sequelæ—Mental dullness may persist for a long period after the attack and occasionally true psychoses result. Various organic nerve lesions have been recorded. Chronic cholecystitis is an important sequel as it may be associated with a carrier state. Bone abscesses may make their first appearance years after the attack. Alopecia particularly in children may be an unsightly sequel.

Diagnosis—The diagnosis of typhoid or paratyphoid is seldom more than suspected on clinical grounds during the first few days. Many other acute infections may give rise to error such as pneumonia, influenza, smallpox, cerebrospinal fever, typhus fever, malaria, undulant fever either of the melitensis or abortus type, miliary tuberculosis, and tuberculous meningitis. Suspicion of the nature of the condition will be aroused if the history, the mode of onset and the symptoms, which have

already been described, are carefully weighed. Considerable assistance will be afforded by the character of the temperature chart. In the paratyphoids early diagnosis may be even more difficult, especially in the mild forms and in those with a gastro-intestinal onset. After the first week the persistence of the symptoms, the appearance of the eruption, the palpable spleen, and the passing of the typical 'peasoup' stools should make the clinical diagnosis certain.

Laboratory Diagnosis—Three laboratory tests are available.

1 *Blood Culture*—A large proportion of positive results may be obtained if blood culture be performed during the first week of enteric. This procedure should always be adopted after four days of pyrexia when there is any suspicion of enteric. At least 5 c.c. of blood collected under strictly aseptic conditions, should be introduced at once into bile salt medium and sent to the laboratory for incubation.

2 *Agglutination Tests (Widal and Weil-Felix Modification)*—Agglutinins in sufficient quantities to produce a positive Widal test appear in the blood serum within eight to fourteen days of the onset. The lowest titre of the serum which can be regarded as significant varies with the type of enteric organisms and with other factors. Of more importance than a single test, e.g., agglutination by a dilution of 1 in 50 is a rising titre, e.g., from 1 in 10 to 1 in 30 during the second week of the disease.

The antigenic structure of each organism is complex, at least three types of agglutinins appear distinguishable by the rate of clumping and its form. (i) *Somatic (O agglutinins)* their appearance is indicative of an active infection. (ii) *Flagellar (H agglutinins)*, type specific provide information as to the particular organism responsible. (iii) *Group agglutinins* (also flagellar) are common to all *Salmonella* organisms except typhoid. Their presence is indicative of a *Salmonella* infection but gives no information as to the particular organism responsible. The Weil-Felix modification of the Widal test involves testing for these different agglutinins. In typhoid fever a *H agglutinin* (indicative of virulence) is described by Felix.

In those who have previously been inoculated with typhoid paratyphoid vaccine (I.A.B.C.) a single test is of little value in detecting the presence of an active infection. Most information is obtained from a rising titre of O agglutinins, since, in the inoculated, H agglutinins may rise during any febrile illness (Anamnestic reaction).

3 *Examination of Stools and Urine*—The specific organisms

by the use of certain culture media may, in the case of *Bact paratyphi B* at least, be recovered from the stools in a high proportion of cases during the first week of the illness. They are still more likely to be isolated from both stools and urine during the second week and onwards.

Treatment—The treatment of typhoid may conveniently be considered under the following headings (1) general, (2) dietetic, (3) symptomatic, and (4) specific.

1 *General*—Absolute rest is imperative from the earliest possible moment until the temperature has remained normal for at least ten days. With the exception of diphtheria, there is no acute infection in which limitation of movement upon the part of the patient is so essential. This is not the same thing as saying that the patient must not be moved. Preferably nursed upon a sorbo rubber bed, the patient's posture must be skilfully changed by the nurse at fairly frequent intervals during the twenty four hours lest pressure sores result. These may readily occur and are a serious complication. Sudden movements by the patient and abrupt movement of the patient by the nurse must be avoided.

2 *Dietetic*—The next essential is a suitable diet. The tendency at the present time is to allow typhoid patients, even during the acute stages of the disease, a far more liberal diet than that usually given in the past including such articles of food as thin bread and butter without crust, minced meat and pounded fish. Mashed potatoes, custards, junkets, and eggs, either raw or soft boiled, are also permissible. In severe cases with digestive disturbances the basis of the diet must be milk supplemented by ample quantities of water. Milk is understood to include such variations in flavouring and later slight thickening as may be devised to relieve the monotony. The patient should consume, in small amounts at a time, not less than three pints of milk in the twenty four hours. Lemon water and weak tea and coffee may be allowed. Small amounts of milk chocolate are well tolerated especially by children. Meat juice or extract may be given to add variety. The patient should be encouraged to take large quantities of fluids, and to these plenty of glucose should be added. This form of carbohydrate is better tolerated than is ordinary cane sugar which in large amounts is liable to cause nausea.

There is no evidence that a liberal diet increases the risk of hæmorrhage or of perforation, while it certainly helps to maintain the patient's strength and to shorten the period of convalescence. While the juice of fruits, such as oranges or lemons is beneficial, it is most important to prevent the

patient from eating those portions of fruit which contain much unabsorbable cellulose. There is little point in giving alcohol as a routine. If its administration be considered advisable to tide over a period of great weakness a dry champagne is the most suitable form to employ.

Apart from the effects of the disease itself, a milk diet tends to produce a furred tongue and an unwholesome condition of the mouth. The hygiene of the mouth is very important, and frequent cleansing of the tongue, teeth, gums, and lips is necessary.

3 *Symptomatic*—(a) *Reduction of Pyrexia*—This is best attained by means of warm or tepid sponging. The more drastic methods of packs and baths should be avoided. The sponging must be carried out as expeditiously and with as little disturbance of the patient as possible. Antipyretic drugs must be avoided as most of them depress the heart.

(b) *Abdominal Distension* is best minimised by careful regulation of the diet. Intestinal antiseptics such as bismuthol and salol possess little if any real value. The same may be said of hexamine, which, moreover, may produce cystitis.

(c) *Hæmorrhage*—Absolute quiet should be secured. If syncope threaten, the foot of the bed should be raised upon blocks. An ice bag should be placed over the lower abdomen, and ice given to suck. A starch and opium enema is sometimes of value in mild cases, but for severe hæmorrhage morphine in a dose of $\frac{1}{4}$ gr. is necessary. In severe collapse intravenous saline or blood transfusion should be given, for cardiac failure, methylamide (coramine) should be injected.

(d) *Perforation*—Treatment is surgical, and its success depends almost entirely on early diagnosis. If operation be delayed for over twenty-four hours, death is almost invariable. Even under favourable circumstances the mortality of perforation is over 50 per cent.

(e) *Myocardial Involvement*—The foot of the bed should be raised, an ice bag placed over the præcordium, and cardiac stimulants applied.

Careful watch must be kept for retention of urine, which must be treated by catheterisation. Other complications must be treated as they arise.

1 *Specific*—Promising results have attended the use of T'chek's "Vi serum" which contains anti-bodies to the so-called "O," "H" and "Vi" antigens of *Bact. typhi* (not *Bact. paratyphi*, be it noted). The serum must be given repeatedly and in full doses early in the attack. Sulphapyridine is valuable for bacilluria.

Mode of Spread and Prevention—It has already been pointed out that enteric infections are derived indirectly from contaminated water supplies, milk or food, or directly from a case of the disease or a carrier.

In most cities and towns in civilised countries the water supply and the system of sewage disposal are satisfactory. In villages, cesspools still persist which may contaminate, by leakage and percolation, the wells from which drinking water is drawn, especially if these be in the chalk. In war time, water supplies must be chlorinated. Milk should be pasteurised. The breeding places of flies such as stable manure, must be dealt with, and all food must be kept covered. The search for and segregation of carriers until they are bacteriologically free, or failing this their continued supervision, is important. The individual case of typhoid must be segregated until at least three consecutive specimens of urine and feces have been shown to be bacteriologically free. Disinfection of the stools and urine of the patient before disposal, and of linen and garments before being sent to the laundry, is imperative. Special precautions must be taken by nurses, the nails must be kept short, on no account must food or drink be taken before the hands have been well scrubbed, and then never in the environment of the patient. They should also be protected by inoculation.

Inoculation is also essential for those living in localities where the disease is prevalent and for troops proceeding abroad. The vaccine is a mixture of *Bact typhi* and *Bact paratyphi* A and B (TAB) or A B and C (TABC). The strains used are rich in vi antigens, these provoke the best and most lasting antigenic response.

The mixed vaccine contains in 1 c.c. 1 000 million *Bact typhi* and 750 million of each of the *Bact paratyphi*. Either three doses of 0.1, 0.5 and 0.75 c.c., or two doses of 0.5 and 1 c.c. are injected at weekly intervals. A further injection should be made a year later if the person is still at risk.

CEREBROSPINAL FEVER

(*Epidemic Cerebrospinal Meningitis* Spotted Fever)

Ætiology—Cerebrospinal fever is caused by the *Neisseria meningitidis* (meningococcus). The organism is disseminated by droplet spray and this is particularly liable to occur under conditions of overcrowding especially in sleeping quarters as in dormitories and barracks. Formidable epidemics tend to

puncture frequently results in a dry tap and cisternal puncture may be necessary. Unless drainage of the cerebrospinal fluid, which is produced in excess, can be re-established hydrocephalus ensues and this entails ultimate death or, at best, mental defect with or without blindness of central origin. The effective treatment of cerebrospinal fever now possible by means of sulphapyridine or sulphathiazole (see *infra* Treatment) makes the occurrence of hydrocephalus unlikely.

Chronic Meningococcal Septicæmia—During the epidemic of cerebrospinal fever which has occurred since the outbreak of war a number of cases of chronic meningococcal septicæmia have been described without meningitis. The onset is sudden with fever, headache and pains in the joints and muscles. After a few days a skin eruption appears consisting of pink or red macules, papules and nodules which are often tender, but rarely hemorrhagic, at any rate at the onset. The condition is apt to be misdiagnosed as subacute rheumatism or erythema multiforme. Although the pyrexia may last for weeks the patient often does not appear to be seriously ill. Blood culture may give a growth of meningococci. Sulphapyridine produces rapid cure, but if the drug is not given meningococcal meningitis often supervenes.

Complications—During the acute phase retention of urine is common. Incontinence of urine and feces may also occur. Broncho-pneumonia may prove troublesome and fatal. Septic arthritis, the meningococcus being present in the pus, occurs occasionally. The following complications affecting the nervous system may occur: hemiplegia, involving the face and limbs, peripheral paralyses, caused by the involvement of spinal nerve roots in the inflammatory exudate, may make their appearance in the limbs, particularly the lower limbs. Various types of mental abnormality occur during the acute meningeal stage, and disappear when this stage subsides. More serious are the mental states which may develop during convalescence. These vary from peculiarities of behaviour to definite dementia, impairment of memory is common. In the majority of cases these mental conditions disappear in time, but certain of them remain permanently. Hydrocephalus is, however, the most frequent and important neurological complication (see p. 763).

Ocular Complications comprise strabismus, ptosis and nystagmus. Conjunctivitis is common. Keratitis associated with perforating ulcer and hypopyon may occur and iritis and optic neuritis are also met with.

Aural Complications—Otitis media may occur early and is due to direct spread of infection from the nasopharynx.

fluid obtained in the meningeal stage is always under increased pressure and may spurt from the cannula. It is turbid and may contain flakes of pus, occasionally it is so thickly purulent as to escape with difficulty from the cannula. The presence of blood is probably always to be ascribed to trauma produced in introducing the lumbar puncture needle into the intrathecal space. Cytological examination of the fluid shows a great increase in the polymorphonuclear leucocytes. Gram negative diplococci can be seen, both intra cellular and extra cellular. The proportion of intra cellular to extra cellular organisms has some prognostic value a preponderance of intra cellular diplococci being of more favourable import. Cultures made immediately upon blood agar and incubated without delay will yield colonies of the meningococcus. The protein content is increased and the chlorides diminished. There is no reduction of Fehling's solution. It should be added that these changes are common to any purulent meningitis.

The course of the epidemic form varies. Death may occur in a few hours or a few days from onset in the fulminating or hyperacute types or the patient may recover from the acute phase and die from some complication or from asthenia later. Recrudescences are common relapses not rare. The usual type of temperature is intermittent, with a tendency to irregularity. This intermittent pyrexia may continue for three weeks or more. The acute phase may end by crisis and recovery or in fatal hyperpyrexia. It must be stressed that these remarks apply to the untreated or imperfectly treated case. With adequate chemotherapy recovery is the rule and is soon brought about.

Recovery is heralded by the disappearance of all objective and subjective signs of meningitis, the temperature falls, and the mental condition which was previously clouded to a greater or lesser degree becomes normal. When the acute phase is at an end the cerebrospinal fluid no longer escapes under pressure, and is clear. The cell count is normal and diplococci are no longer to be seen, the fluid is sterile on culture and its power to reduce Fehling's solution returns.

Posterior Basic Meningitis—A. C. Hampson regards this condition as a sequel in infants to a mild attack of acute meningitis which has escaped diagnosis or of one in which the treatment of the acute phase has not been effective. Thick purulent exudate at the base of the brain results in the closure of the foramina of Magendie and Luschka connecting the subarachnoid space with the ventricular system. There is marked head retraction and bulging of the anterior fontanelle. Lumbar

puncture frequently results in a dry tap and external puncture may be necessary. Unless drainage of the cerebrospinal fluid, which is produced in excess, can be re-established, hydrocephalus ensues and this entails ultimate death or, at best, mental defect with or without blindness of central origin. The effective treatment of cerebrospinal fever now possible by means of sulphapyridine or sulphathiazole (*vide infra* treatment) makes the occurrence of hydrocephalus unlikely.

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Complications—During the acute phase retention of urine is common. Incontinence of urine and faeces may also occur. Broncho-pneumonia may prove troublesome and fatal. Septic arthritis, the meningococcus being present in the pus, occurs occasionally. The following complications affecting the nervous system may occur: hemiplegia, involving the face and limbs, peripheral paralysis, caused by the involvement of spinal nerve roots in the inflammatory exudate may make their appearance in the limbs, particularly the lower limbs. Various types of mental abnormality occur during the acute meningial stage, and disappear when this stage subsides. More serious are the mental states which may develop during convalescence. These vary from peculiarities of behaviour to definite dementia, impairment of memory is common. In the majority of cases these mental conditions disappear in time, but certain of them remain permanently. Hydrocephalus is however, the most frequent and important neurological complication (*vide p 763*).

Ocular Complications comprise strabismus, ptosis and nystagmus. Conjunctivitis is common. Keratitis associated with perforating ulcer and hypopyon may occur and iritis and optic neuritis are also met with.

Aural Complications—Otitis media may occur early and is due to direct spread of infection from the nasopharynx.

Nerve deafness may occur, but usually disappears in convalescence occasionally it becomes chronic

Diagnosis—In the septicemic stage it may be impossible to distinguish the condition from other acute diseases with a similar form of onset. Such diverse conditions as pneumonia, influenza, hypertoxic scarlet fever, smallpox, typhoid, typhus, relapsing fever, plague, and heatstroke have been confused. The petechial rash has been diagnosed as that of typhus and hæmorrhagic smallpox. In the meningeal stage the diagnosis is confirmed by the examination of the cerebrospinal fluid. Pneumococcal and streptococcal meningitis are clinically indistinguishable but are usually secondary to a primary focus elsewhere. It is a wise precaution as advocated by Flexner, to swab the nasopharynx. Meningococci may be found in the nasopharyngeal secretion even if absent from the cerebrospinal fluid at the time of the first puncture.

Treatment—The sulphonamides are essential and must be given in massive doses at the earliest possible moment repeated at four hourly intervals in order to maintain a sufficient concentration of the drug in the blood stream and cerebrospinal fluid. In the former this level should be from 10 to 15 mgm per 100 cc and in the latter 5 mgm per 100 cc. For adults the initial dose of sulphapyridine should be one of 2 gm given by mouth and during the first forty eight hours a total daily dose of 6 gm is prescribed. Subsequently the amount is halved and later reduced to one third (the four hourly intervals being maintained). For children half these doses suffice. In severe cases the first and second doses should be given intravenously. Orally sulphathiazole is sometimes better tolerated than sulphapyridine. Further details regarding the use of the sulphonamides and toxic reactions which may be produced are given on page 70.

Lumbar puncture must be performed at the outset to confirm the diagnosis and should be repeated at intervals to gauge progress. Adequate chemotherapy renders therapeutic lumbar punctures unnecessary. Anti meningococcal serum is falling into disuse. If employed at all it must be regarded as secondary to chemotherapy and a single dose (50 to 100 cc) of polyvalent serum injected by the intravenous route. Intrathecal therapy is not now employed either for sulphonamide or serum.

Prevention—Isolation should be maintained for at least two weeks after the onset or until two negative nasopharyngeal swabbings have been obtained at four day intervals. Concurrent disinfection of nasal and oral discharges is important.

Efficient masks should be worn by attendants. Contacts and carriers of meningococci should be kept under observation until shown to be bacteriologically free. Promising results in the clearance of carriers have been obtained with sulphapyridine by Fairbrother. They should be encouraged to obtain abundant fresh air and exercise. In the presence of an outbreak, attention to general health and hygiene is important. Particular care must be taken to ensure that proper spacing in sleeping quarters is available. During prevalence of the disease the kissing of children should be avoided, particularly by those who have been in contact with a case.

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SEPTICÆMIA

The discovery of bacteria in the circulating blood indicates a *bacteræmia*. This condition probably occurs fairly frequently without producing severe symptoms. Thus streptococci and other organisms have been demonstrated in blood cultures taken soon after minor operations, such as tooth extraction or tonsillectomy. By the term *septicæmia*, however, more is meant than the presence of organisms in the blood. Septicæmia indicates a clinical condition, which usually results from the presence of haemolytic streptococci or staphylococci in the blood stream. Septicæmia due to either of these organisms is an acute condition, but when the infecting organism is the *Streptococcus viridans* an entirely different clinical picture is produced, which is known as subacute bacterial endocarditis (vide p. 527). Septicæmic phases also occur in infections by organisms other than the streptococci and staphylococci. Thus in the early stages of pneumococcal pneumonia the enteric fevers and meningococcal meningitis blood cultures may be positive, but this is usually only a transient finding.

In septicæmia due to the *Streptococcus hemolyticus* the source of infection is often obvious and of a local nature such as cellulitis, whitlow, a finger pricked at operation or autopsy, tonsillitis, or uterine infection. In some cases septicæmia may occur without an obvious focus.

The development of septicæmia probably depends mainly on the virulence of the infecting organisms and the resistance of the tissues to infection. Thus when the resistance is lowered by the presence of a chronic disorder, for instance Graves' disease, a virulent septicæmia is liable to occur as a terminal event.

The onset of streptococcal septicæmia is abrupt. If there is a local lesion a lymphangitis is often visible, and the patient presents certain clinical symptoms which point to blood stream infection. The most important and constant of these is the occurrence of rigors, should these occur in the presence of a septic focus they almost certainly indicate a septicæmia, and blood culture is likely to be positive. Fever of an irregular type is almost invariable, usually much higher at night than in the morning, and continued sometimes over a period of many weeks. Two other important symptoms are progressive anæmia of hypochromic type and troublesome diarrhoea, which fails to react to the ordinary remedies. The tongue is smooth red desquamated and often sore. The urine generally contains albumen casts and sometimes red blood cells. The skin may show erythematous rashes and petechiæ and the spleen is often slightly enlarged. When metastatic abscesses are formed the condition is often described as *pyæmia* rather than septicæmia. Such abscesses are specially likely to develop in the pericardium pleura, or joints. It is important to watch carefully for the development of symptoms pointing to formation of pus as their relief by surgical drainage is essential.

STAPHYLOCOCCAL SEPTICÆMIA

Infections by the *Staphylococcus aureus* are usually primarily on the skin, and this organism is responsible for boils and carbuncles. The amount of general constitutional disturbance may be slight while the inflammatory process remains localised, but if the organisms reach the blood stream, either as a result of lowered tissue resistance or ill judged surgical measures a septicæmia may be produced in which metastatic abscesses are striking features. These may be found most commonly in the bones in the perinephric tissues arising from a staphylococcal abscess of the renal cortex in the pericardium pleura or elsewhere. Not infrequently there may be a latent period of days or weeks between the occurrence of a boil and the development of symptoms pointing to a metastatic staphylococcal lesion such as a perinephric abscess. Often, indeed, blood culture is negative but a transient staphylococcal bacteriæmia must be presumed. In every case of prolonged pyrexia without obvious cause the possibility of a staphylococcal abscess must be borne in mind particularly if there is a polymorphonuclear leucocytosis. Pyrexia may continue for several weeks before tenderness or bulging in the loin points to a perinephric abscess. Symptoms may also be misleading. Localised staphylococcal

abscesses in the lungs may cause hæmoptysis and lead to a mistaken diagnosis of pulmonary tuberculosis. Swain of the psoas due to perinephric infection may simulate disease of the hip joint, or an osteomyelitis, especially in a child, may be regarded as rheumatic.

Usually staphylococcal septicæmia is less acute in onset than is streptococcal septicæmia. When localised metastatic abscesses are formed, if these can be adequately drained the outlook is relatively good, and it is remarkable that desperately ill patients may ultimately make a complete recovery after a long illness with multiple foci of infection such as empyema, pulmonary or perinephric abscesses.

TREATMENT OF SEPTICÆMIA

The risk of generalised infection can be minimised by careful treatment of local inflammatory conditions. Moreover, particularly in staphylococcal infections, such as multiple boils or carbuncles, the likelihood of a septicæmia can be diminished by due attention to the general health of the patient, who should be advised to take a prolonged holiday following septic infections. An attempt may be made to raise the resistance by a course of injections of an autogenous vaccine, which is sometimes effective in staphylococcal infections.

There are two main aspects of the treatment of septicæmia whether streptococcal or staphylococcal: (1) Measures designed to improve and maintain the resistance and nutrition of the patient; (2) chemotherapy. The former are of importance and include good nursing, a large fluid intake, if possible 6 pints per diem, glucose and an alkaline mixture. Morphia may be necessary for pain and sleeplessness. The patient must be frequently examined to detect localised suppuration. Hypodermic injections of 1 c.c. of coramine several times daily are often of value if the heart-rate is very rapid. Repeated blood transfusions, not more than 10 oz. at a time, are of undoubted value even if the patient is not strikingly anæmic. If the temperature is above 104°, tepid sponging is advisable. Quite apart from the lowering of temperature produced, the patient feels more comfortable. As the disease is often prolonged, a nutritious diet should be allowed, together with large amounts of fluid. Immuno-transfusions are of doubtful value.

Chemotherapy.—The introduction of the sulphonamide group of drugs, the best known of which are sulphapyridine, sulphanilamide, and sulphathiazole, has probably been the

greatest therapeutic advance ever made in the history of medicine. Their administration has revolutionised the prognosis not only in streptococcal septicæmias but in diseases due to other micro-organisms such as the pneumococcus, meningococcus, *B. coli*, and gonococcus, in addition to numerous others such as Flexner's dysentery bacillus and the anthrax bacillus, where their value is less definitely proved. In the tissue fluids, such as the blood and cerebrospinal fluid, they exercise a bacteriostatic effect, i.e., they inhibit multiplication of the bacteria. For their effective use the sulphonamides must be given in sufficient dosage to produce a concentration which will promote bacteriostasis. There is some evidence that in small doses given at irregular intervals they not only fail to inhibit growth of bacteria but may even do harm by promoting the development of organisms which are resistant to sulphonamides, rendering them so called "sulphoamide fast". It is therefore clear that the sulphonamides should never be given except after careful consideration and in adequate dosage, and it is impossible to condemn too strongly the tendency to give the drugs in minor illnesses such as coryza or influenza. The tubercle bacillus appears to be unaffected by sulphonamides, as to a less extent are staphylococci.

Sulphapyridine (M & B 693, Dagenan) can be given by mouth, intravenously or intramuscularly. Sulphanilamide and sulphathiazole are given orally. Sulphapyridine is the most effective of the sulphonamide group in pneumococcal and meningococcal infections, sulphanilamide in streptococcal, and sulphathiazole in gonococcal. Sulphathiazole possibly also has some effect against staphylococci. Owing to the rapid excretion of this drug it is essential that it should be given at least four-hourly throughout its administration.

The route of administration of choice is the oral, as intramuscular injection is painful and with intravenous injections even a small amount of drug outside the vein produces a grave local reaction. In patients however who are dangerously ill *such as those suffering from streptococcal septicæmia or cerebrospinal fever*, it is often necessary in order to obtain rapidly a high concentration in the blood to give sulphapyridine derivatives intravenously at the beginning of treatment. Two grm. of the sodium salt of sulphapyridine (M & B 693 soluble) can be given with a 10 c.c. syringe diluted with distilled water. Extreme care must be exercised to ensure that no drug is injected into the tissues. If intramuscular injection is employed the drug must be injected deeply into the muscles of the buttock. The pain can be partially avoided by simultaneous

with sulphonamides there is often a rise of temperature which is apparently the result of the drug rather than a recrudescence of the infection

6 *Hamaturia*—This is especially liable to occur with sulphathiazole unless the patient is made to take large amounts of fluid. It is probably due to crystallisation of the drug in the renal tubules.

RHEUMATIC FEVER

Rheumatic fever, or, as it is often called, acute rheumatism, is a specific disease characterised by fever, arthritis of a well defined type, and a tendency to involve the heart. It certainly has no connection with the degenerative forms of arthritis known as osteoarthritis and its clinical picture and age incidence does not resemble infective or rheumatoid arthritis.

Ætiology—Rheumatic fever is primarily a disease of temperate climates in the northern hemisphere. It is particularly common in England, more especially in the larger cities where overcrowding is prevalent. It is essentially a disease of childhood and of young adult life, and is almost unknown over the age of forty except in persons who have already had a previous attack. There is no conclusive evidence that the disease is hereditary. It is particularly common in districts which besides being overcrowded are low lying and damp.

The cause of rheumatic fever is still unknown. There is considerable evidence that the disease occurs in children who some ten days previously have suffered from tonsillar infections with hemolytic streptococci. Although there is little bacteriological evidence to prove that the disease is directly due to streptococcal infection it is possible that the presence of such an infection may in some way produce a sensitisation, which may eventually manifest itself as the symptom complex recognised as rheumatic fever. It has also been suggested that the disease is due to a virus. Probably several factors are necessary for the development of acute rheumatism, in which both streptococcal infection and allergy may play a part.

Symptoms—There is frequently an association between rheumatic fever and chorea. Sometimes chorea may develop in a patient who has previously suffered from rheumatic fever, and in chorea the heart often becomes involved exactly as it is in rheumatic fever (*vide* article on Chorea, p. 820).

In most cases rheumatic fever has a gradual onset with vague pains in the limbs, general malaise, and frequently a sore throat. The temperature soon rises, and ranges from 102° - 104° as the disease becomes well established.

Joints.—The most characteristic features about the joints in acute rheumatism are that the pain shifts from joint to joint and that the arthritis is always multiple. Most commonly the larger joints such as knees, ankles, and shoulders are first affected, while the small joints of the hands are usually spared. Although the pain may be severe, particularly on movement or pressure, there is remarkably little to see on examining the affected joint. Frequently nothing abnormal can be detected, but sometimes the skin may be flushed and the joint slightly swollen by an effusion of fluid. The skin never becomes glazed, indurated, or cedematous, as may often be the case with pyemic joints. In the course of a day or two the joints first affected become free from pain and tenderness, while other joints begin to be involved in a similar manner.

Skin.—In severe rheumatic fever, particularly in adults, sweating is profuse and sometimes there is a diffuse erythema, which has no clinical significance.

Beneath the skin, but not actually in it, there are sometimes multiple discrete lumps about the size of a pea, which have been termed *rheumatic nodules*. Occurring mainly in children, they always indicate a severe infection, usually with cardiac involvement. The commonest sites for their occurrence are around the wrists, elbows, and over the superior occipital protuberances.

Blood.—A hypochromic anaemia develops rapidly and the leucocyte count is usually high, about 15,000 to 20,000.

Heart.—No infection is more prone to attack the heart than rheumatic fever, and it is this feature which renders the disease so serious. In every case, however mild, there is some degree of myocarditis, as exemplified by the tachycardia which often persists for some time after the temperature has fallen and joint symptoms have disappeared. The first sound at the apex is muffled in character and a soft systolic murmur may develop, perhaps as a result of dilatation of the mitral ring. In about 50 per cent. of cases there is evidence of a definite endocarditis, which affects most commonly the mitral valve, often both mitral and aortic, and rarely the aortic alone. A systolic murmur, blowing in character, best heard at the apex, and propagated into the axilla, often indicates mitral endocarditis. With involvement of the aortic valve a soft diastolic bruit is heard either over the base of the heart or along the

edges of the sternum. In addition pericarditis may occur, particularly in severe cases or in recurrent attacks. It may be accompanied by left sided pleurisy. The heart lesions of rheumatic fever are dealt with in more detail in the section on 'Diseases of the Heart.'

Pyrexia—In children the temperature is seldom above 102° , but in adults it is often higher. Hyperpyrexia, common before treatment with salicylates, is now almost unknown.

Types of Rheumatic Fever.—The disease as described above is such as is seen in severe cases in young adults. In children the joint symptoms are usually much less marked, it is quite the exception under fifteen years of age for any definite swelling of the joints to occur, and often the pain is much less than in adults. In some cases, indeed, there may be no noticeable arthritis at all, and the diagnosis depends on the development of cardiac lesions. These are much more frequent and severe in children than in adults. The mild type of the disease as seen in children is often called subacute rheumatism. The temperature is only slightly raised with vague aching in the joints, considerable impairment of the general health, and some anæmia, such cases may be associated with cardiac involvement.

Diagnosis—There is one pitfall in the diagnosis of rheumatic fever which may cost the practitioner his reputation and the patient his life namely, a mistaken diagnosis of acute rheumatism in a case of osteomyelitis. Attention to the maxim that rheumatic fever should never be diagnosed in a monoarticular arthritis will go a long way towards avoiding so disastrous an error. Further, in osteomyelitis the skin over and surrounding the joint has a red, glazed appearance, and often pits on pressure. In addition a point of acute tenderness can usually be made out over the site of the disease in the bone.

Acute rheumatoid arthritis may simulate rheumatic fever as regards the temperature, but the joints involved usually include the small joints of the hands, the cervical spine and often the temporo-mandibular joints all of which are but rarely affected in rheumatic fever. Moreover there is less tendency for the pain to shift from joint to joint and periarticular thickening and deformity of the affected joints occur early with striking muscular wasting.

A multiple arthritis may occur in the course of many diseases such as pneumonia, dysentery, scarlet fever, pyæmia, syphilis, gout, and typhoid or it may follow gonorrhœa. Failure of the pyrexia and pain to react to adequate treatment with salicylates is strong presumptive evidence that the case is not one of acute rheumatism.

Treatment—The main object in the treatment of rheumatic fever is to avoid cardiac complications with their attendant menace of chronic valvular disease. Only too often in spite of everything endocarditis develops but there can be no doubt that absolute rest in bed from the onset with careful nursing go far to prevent heart disease. Owing to the profuse sweating the patient should be nursed in blankets rather than sheets and if the joint pains be severe immobilisation of the affected joints by sandbags and elevation of the bedclothes by a cradle are desirable. Local applications to the joints such as methyl salicylate liniment, may give some relief. Even when the heart is unaffected the patient should remain in bed for a minimum of six weeks while in cases with obvious cardiac involvement as many months may be required.

Salicylates are of the greatest value in reducing the temperature and abolishing the joint pains in rheumatic fever. They have however little effect in preventing cardiac involvement. The drug is best given as sodium salicylate (sod salicyl gr xxx, sod bicarb gr l syr auranti ʒss, aq ad ʒss) for adults until the temperature falls a daily total of 180 to 210 gr of salicylate should be given, the amount may then be decreased gradually to 10 gr daily by cutting down the frequency of doses. The bicarbonate prevents salicylate poisoning, the symptoms of which are tinnitus, vomiting and sometimes delirium.

The diet is not important, but during the initial period of pyrexia the patient will probably only be willing to take fluids. If the pain is severe enough to prevent sleep Dover's powder may be necessary. Within forty-eight hours of adequate treatment with salicylates there is always a marked improvement in the symptoms. In spite of this it is most important not to allow the patient to sit up in bed or otherwise exert himself too early. The pulse rate is the most important guide as to when a sitting posture may be allowed. This must be strictly forbidden as long as there is any tachycardia. It is often difficult to decide at what stage the disease has become quiescent. The sedimentation rate is a valuable guide. If it is high the condition is still active and further rest is indicated.

Prognosis and Prophylaxis—The immediate mortality of rheumatic fever is relatively low, but it leaves a heavy toll in deaths from cardiac failure in later life. Unfortunately it is a disease which tends to recur more especially if the heart has been attacked. With each recurrence the chances of severe and permanent cardiac damage become increased. In every

case of rheumatic fever the problem therefore arises of how best to avoid recurrence. Return to crowded and insanitary surroundings should be prevented. If possible the patients should live in the country and all predisposing causes of further attacks such as overwork, cold and chills must be avoided. Unfortunately, at any rate in hospital patients, this is an ideal unattainable in the present state of society and economics.

Tonsillectomy is inadvisable unless there is gross sepsis; in any case the operation should not be performed until convalescence is completed.

ERYTHEMA NODOSUM

This condition is not a manifestation of acute rheumatism. It is chiefly found in children and young adults. Indurated red areas appear chiefly over the shins, rarely on the forearms. These are raised above the surface of the skin and are very tender. Usually circular or oval, they vary in size from a half to two inches in diameter. At first they are red, but later become purple. The degree of constitutional disturbance is very variable. Often there is little or none, but sometimes there may be fever and vague joint pains. Unlike acute rheumatism erythema nodosum does not produce cardiac lesions.

The ætiology of the condition is not definitely established, but it is probably a cutaneous response to bacterial allergens which are usually either streptococcal or tuberculous. This is suggested by the fact that patients suffering from erythema nodosum frequently show evidence of chronic infection, such as enlargement of the tracheo-bronchial glands, infected tonsils and chronic enlargement of the glands in the neck. Some cases give a positive Mantoux test and are probably tuberculous in origin; others react to hæmolytic streptococcal endotoxin.

There is no specific treatment, and with rest in bed and local applications of lead lotion the lesions usually clear up within a fortnight. In view of the possible tuberculous origin of the disease the patient should be investigated from this point of view, including an X-ray of the chest.

INFLUENZA

Probably no diagnosis is made so frequently, and often with so little justification as that of influenza. The layman indeed is very apt to term any severe nasal catarrh or infection of the

upper respiratory tract an influenzal attack. How different such cases are from the true epidemics of influenza is well illustrated by the devastating pandemic which occurred in 1918 and 1919. Perhaps the most striking point about the disease is the way in which it occurs in widespread epidemics, independent apparently both of climate and nationality. In 1918 the number of deaths from the disease must have far exceeded the total of those killed in the War. Similar pandemics occurred in 1889 and 1890.

Ætiology.—The brilliant work of Laidlaw and others has shown that influenza, at any rate in some epidemics, is due to infection by a virus. Pfeiffer's bacillus, formerly thought to be the causal organism, is now known to be a secondary invader, as also may be other organisms, such as streptococci or pneumococci. The complications of influenza, such as pneumonia, are due not to the virus but to secondary invading organisms. The disease is extremely infectious, as the virus is widely scattered by the patient's cough. An attack produces a relatively short period of immunity, and some people appear to be specially susceptible to infection. In pandemics the disease is usually more severe in young and healthy adults than in infants or the aged.

Symptoms.—The onset is always sudden and the incubation period very short. Any attempt to describe the clinical features is necessarily difficult owing to the wide variations which occur in the disease in different localities and at different times. The cases can, however, be divided roughly into the so-called simple influenza and those with pulmonary involvement. The former type is met with in periods between widespread epidemics, and also includes the great majority of the cases even in pandemic periods. The disease begins with severe headache, aching of the joints, and pyrexia: the fauces are red and injected, but without definite tonsillitis; a hard, hacking cough due to tracheitis develops early, but usually there is little sputum. After four or five days of irregular pyrexia, with considerable prostration, the symptoms disappear and a slow convalescence ensues. In some epidemics complications such as acute otitis media, mastoiditis, sinusitis, and rarely meningitis are frequent. Severe post-influenzal mental depression is not uncommon.

In some epidemics gastro-intestinal symptoms are prominent, and such cases are often described as *gastric influenza*. The temperature is rarely above 100° F.; the tongue is furred and the patient suffers severely from nausea and vomiting. There is abdominal discomfort rather than pain, and the bowels are

usually constipated. Probably the symptoms are due to influenzal infection but needless to say the diagnosis must be made with caution especially in the absence of an epidemic.

The pneumonic or septicæmic type of influenza presents a very striking picture. Often starting with symptoms similar to those of the simple form of the disease it rapidly becomes apparent that the illness is of a grave type. The breathing is rapid and shallow though there is no obvious respiratory distress, cough is frequent and troublesome, the sputum becomes considerable and is frothy and blood streaked. But perhaps the most striking feature is the colour of the patient which ranges from pink in the milder cases to a characteristic heliotrope, lilac or violet hue in those who are desperately ill. The pyrexia is not necessarily high, in fact in the more severe cases the patient may die with a subnormal temperature. Although involvement of the lungs is the most obvious feature streptococci can sometimes be cultivated from the blood, indicating the presence of a true septicæmia. These organisms, however, are probably secondary invaders. The kidneys are affected, as is shown by the presence of albumen and casts. The mind is clear and alert to within a few hours of death though occasionally delirium and convulsions occur which are not however, necessarily indicative of a true meningitis.

The physical signs in the chest are very variable, and are of little value in assessing the severity of the disease. Sometimes nothing is heard except a few scattered rales and rhonchi, sometimes there may be dullness and bronchial breathing over a considerable area of lung. Often the physical signs vary considerably from day to day. The pulse is usually relatively slow compared with the temperature and respiration rate. Pleural effusions, empyema or rarely pulmonary abscess may be serious complications or sequelæ.

Prognosis—In sporadic cases of influenza death hardly ever occurs. In epidemics the death rate varies with the proportion of pneumonic cases. The most significant point in the prognosis is the colour of the patient, those with the typical heliotrope tint invariably die very rapidly.

Diagnosis—In the presence of an epidemic the diagnosis is easy. With sporadic cases the diagnosis should not be made until other pyrexial illnesses have been excluded.

Treatment—There is no specific treatment for influenza, but without doubt immediate confinement to bed tends not only to shorten the course of the illness but diminishes the incidence of complications. It also helps to limit the spread of the disease. Symptomatic treatment with aspirin (gr x),

Dover's powder (gr \times), and steam inhalations give relief. If cough is troublesome, a linctus containing equal parts of syrup of codæine phosphate and syrup of Virginian prune is often effective in 2 drachm doses.

The treatment of influenzal pneumonia does not differ essentially from that of other forms of pneumonia. In severe cases oxygen should be given. Sulphapyridine is certainly of great value if given early and in adequate doses (vide p. 70). It is ineffective in uncomplicated cases of influenza.

Convalescence is often slow even after mild attacks and several days of rest should be insisted on before the patient returns to work. In some cases tachycardia, extra systoles, and myocarditis develop after the acute strigo of the illness is over, necessitating prolonged rest.

UNDULANT AND ABORTUS FEVER

Two closely allied organisms, *Brucella melitensis* and *Brucella abortus*, cause in man a prolonged pyrexia with a tendency to remissions and relapses. *B. melitensis* is primarily an infection of goats. *B. abortus* of cattle. Man is infected through drinking the milk. Although there are minor differences in the clinical features of undulant fever (Malta fever) and abortus fever, there is sufficient similarity in the two infections, as seen in man, to warrant their being described together.

Symptoms—The onset is gradual with pyrexia, sweating and sometimes rigors. Although the fever may be high the patient often feels relatively well, and sometimes may even remain ambulant for long periods. The pulse is relatively slow and the patient is clear and alert. Sometimes the spleen is just palpable. In undulant fever joint pains and arthritis may occur, but this complication is rare in abortus fever. The symptoms may last for many months with exacerbations or remissions.

Diagnosis—The possibility of abortus fever must always be borne in mind in any case of prolonged pyrexia without an obvious cause. Suggestive clinical features are the very profuse sweating, relatively slow pulse and the fact that the patient is not as ill as might be expected with the prolonged fever. In all cases of continued fever agglutination tests should be performed. The agglutination titre usually rises to 1 in 1 000 or even higher. The organism can sometimes be obtained by blood culture.

Prophylaxis and Treatment—Efficient pasteurisation affords complete protection. As many apparently healthy cows may be carriers raw milk is always potentially dangerous.

The disease tends to spontaneous cure though relapses may continue for many months. Rest in bed in the earliest stages probably cuts short the duration of the illness but it is extremely doubtful whether sulphonamides or indeed any specific treatment is of value.

SPIROCHÆTOSIS ICTERO HÆMORRHAGICA

Spirochætosis ictero hæmorrhagica (Weil's disease) is a febrile jaundice due to infection by a spirochæte the *leptospira ictero hæmorrhagica* which is excreted in the urine of rats. Presumably the organism penetrates the sodden but intact human skin. The disease occurs in miners workers in sewers fish cleaners or wherever water is likely to be contaminated by the urine of rats.

Symptoms—The onset is invariably sudden with high temperature and often a rigor. Headache vomiting and severe muscular pains are the main features during this initial febrile stage but there is often nothing specially characteristic until jaundice develops on the fifth or sixth day. During the pre icteric stage the diagnosis may be suggested by the occupation labial herpes often hæmorrhagic and conjunctivitis.

The jaundice is deep and the patient appears orange coloured. Bile is present in the urine but the fæces are not necessarily clay coloured. In severe cases there is great prostration and often a tendency to hæmorrhage producing epistaxis petechiæ or even hæmatemesis or melæna. The urine contains albumen casts and blood. Usually after a week or two the jaundice gradually disappears and convalescence is established but a proportion of the patients develop anuria and die from uræmia and exhaustion. The temperature falls within a few days of the development of jaundice but there is sometimes a secondary rise of temperature about the third week of illness. Probably many mild cases occur in which jaundice is absent. Except in localised epidemics these are likely to be misdiagnosed as influenza.

Diagnosis—A definite diagnosis can be made by inoculation of the patient's urine into a guinea pig. The urine does not contain the leptospira until about the tenth day. Agglutination tests are likely to be positive about the sixth day. Blood culture is negative except during the pre icteric stage.

A polymorphonuclear leucocytosis is found in spirochetosis in contrast to the normal or low white cell count in toxic or infective jaundice. Spirochetosis should be thought of as a possibility in all cases where jaundice develops after some days of a severe febrile illness especially if the patient's occupation is one which involves getting wet in rat infested surroundings.

Treatment—A specific anti serum is available, which is of value especially if given within the first week. Thirty to forty c.c. are given intramuscularly or intravenously. As hepatitis is present the patient should take large amounts of glucose and fluids and fats should be avoided. Symptomatic treatment is required for the headache and other symptoms.

TETANUS

Ætiology—The disease is due to infection by the *Tetanus bacillus* which is usually present in cultivated ground, road dust, and horse manure. The bacillus is anaerobic and forms spores which are extremely resistant to heating and drying. Infection occurs through contamination of wounds though these may be so slight that they may escape detection. Cases are on record due to infected catgut.

Pathology—The bacilli multiply at the site of inoculation with the production of a most virulent toxin. The latter has a special affinity for the central nervous system thus it reaches by passing up the motor nerves, possibly through the axis cylinders or in the perineural lymphatics. Once the toxin reaches the central nervous system it appears to form some kind of combination with the nerve tissues and the symptoms of the disease become manifest. Owing to the anaerobic character of the bacillus it is more likely to flourish in deeply punctured wounds than in superficial abrasions.

Tetanus bacilli in a virulent form may often be cultivated from the site of infection long after the disease has become established, whether such a focus continues to manufacture toxin is not clearly established. It is possible that the tissues of the patient may have already acquired anti tetanic powers sufficient to neutralise the formation of further toxin though ineffective in dealing with that formed and conveyed to the nervous system during the earlier stages of the disease.

At autopsy there may be hypostatic pneumonia and occasionally rupture of muscles particularly the rectus abdominis owing to the spasms.

Symptoms—The period which elapses between the infection

and the development of symptoms varies from two to twenty days or even longer. The first sign of the disease is usually a stiffness or rigidity of the muscles of mastication or of the neck muscles, which is frequently first noticed when the patient awakes in the morning. The description of a patient with tetanus, written by Hilton Fagge in his textbook of medicine nearly fifty years ago, cannot be improved upon. After describing the inability to separate the teeth known as *trismus*, he continues: "The toxio spasm increases and spreads to the muscles of the trunk, and to at least the upper parts of the limbs. The patient's aspect is then very remarkable. The face may be described as having an unnaturally aged appearance, the forehead being wrinkled and the features contracted and drawn. The angles of the mouth are wide apart, and the lips are stretched over the closed teeth, so as to produce a fixed smile, which is known as the *risus sardonicus* and is at once seen not to be indicative of any pleasurable feeling. The *alæ nasi* are thrown outwards, and the nasolabial furrows are exaggerated. The eyelids are half closed, but the eyes are said to have a staring expression, although their muscles are seldom if ever affected by the cramp. The jaws may be so firmly clenched that not even a paper knife can be wedged in between the teeth, or perhaps they can still be separated a little way from one another. The body is rigid, and it is almost curved, so that the back forms a deep hollow. This condition is called *opisthotonos*. At the same time the chest is, of course, thrown forwards, and it is more or less fixed in a state of expiration, while the abdomen is flat or sunken. The tension of the affected muscles is obvious to the touch and sight, this is particularly the case with the recti abdominis, which are often described as feeling 'as hard as boards,' and which in persons who are not too fat stand out in knotty masses through the integuments."

Pain is an early feature of the disease, the breathing is embarrassed and the voice reduced to a whisper. From time to time reflex spasms with *opisthotonos* occur, which are usually attended by a great increase of pain. These paroxysms may occur spontaneously or be brought on by slight external stimuli, such as a sudden noise or draught of cold air. The mind usually remains perfectly clear. Pyrexia is variable but sometimes it may be very high. Death may occur early in the disease from respiratory paralysis, in the more protracted cases even though the spasms may have ceased, the patient may die of exhaustion and heart failure.

What is known as "local tetanus" is met with occasionally,

especially in those who have received prophylactic serum, in this spasms affect only groups of muscles in the neighbourhood of the site of infection.

Symptoms of tetanus may develop when an old wound is reopened. Before any such operation a prophylactic dose of serum (3 000 units) should be given.

Diagnosis—Strychnine poisoning may simulate tetanus. In this the muscles of the hands are more often involved than in tetanus and, also, the muscles do not remain rigid between the paroxysms. The trismus of tetanus must be distinguished from that due to local causes about the jaw, such as dental irritation. Occasionally the fear of lock jaw may produce hysterical symptoms which superficially may resemble tetanus.

In meningitis although opisthotonos and neck rigidity may be striking absence of trismus usually makes the diagnosis apparent. Moreover in tetanus the cerebrospinal fluid is clear unless serum has been given intrathecally.

Prognosis—The longer the interval between the occurrence of the wound and the first manifestations of the disease the better the prognosis. Where this is less than eight days the outlook is bad. Even more important from the prognostic point of view is the length of time that elapses between the first symptoms of trismus and the onset of reflex spasms. When this is less than forty eight hours recovery is improbable. Unfortunately, even with new methods of treatment, there is little improvement in the prognosis in fully developed tetanus.

Prophylaxis and Treatment—The value of anti tetanus serum as a prophylactic measure is universally recognised. At least 3 000 units should be injected subcutaneously as early as possible after all wounds, particularly if these have occurred on a road or cultivated ground. Even a graze on the skin or small puncture wounds are potentially dangerous. Further injections should be given at weekly intervals until the wound is completely healed. Failure to give prophylactic serum can only be regarded as criminal negligence.

Active immunisation with tetanus toxoid produces an immunity, the degree and duration of which is doubtful and as a prophylactic measure it in no way supersedes the prophylactic serum. Two doses of 1 cc. should be given subcutaneously at an interval of not less than six weeks.

In the treatment of tetanus there are four essentials (1) an adequate amount of serum given at the earliest possible moment with a view to the neutralisation of further toxin formation, (2) sedatives to diminish muscular rigidity and the

severity of spasms (3) adequate nutrition (4) cleansing and drainage of the wound

Serum Treatment—Although it is doubtful whether anti-tetanic serum has any appreciable effect in neutralising toxin which has already reached the nervous system it is certainly able to neutralise any further toxin which may be formed in the focus of infection. The best method of giving serum is intravenously and a large dose certainly not less than 100 000 units and preferably 200 000 units should be given at once. When large doses of serum are given intravenously it has been shown that a considerable portion of the antitoxin remains in the blood for three weeks or longer and there is therefore no need to give subsequent doses. Serum should not be given intrathecally as it frequently produces an aseptic meningitis with severe cerebral symptoms. Intramuscular injections may be used as an adjuvant to but not as a substitute for, intravenous therapy.

Sedatives—When the spasms are frequent and severe the use of avertin has proved most valuable. It should be given rectally in full doses (0.1 gm per kilo of bodyweight). Avertin usually abolishes spasms and rigidity thereby preventing exhaustion and facilitating feeding. Rectal paraldehyde is also useful in doses up to 6 drachms. It is given with normal saline (1 drachm to 1½ oz of saline). Avertin has abolished the need for inhalation anaesthetics.

Feeding—Death from exhaustion is less probable if the nutrition of the patient can be maintained. Spasms and rigidity involve the expenditure of much muscular energy, and an attempt must be made to give at least 2 000 calories daily mainly in the form of glucose, milk or eggs. If necessary a stomach or nasal tube may be used when the patient is under avertin.

Treatment of the Wound—The wound should not be dealt with until several hours after a large intravenous dose of antitoxin. Otherwise there is liable to be a flood of unneutralised toxin into the circulation. If there is any pus it should be given free drainage and small wounds or abrasions over which scabs have formed should be opened up and cleansed with hydrogen peroxide.

ANTHRAX

Anthrax is primarily a disease of herbivorous animals but occasionally occurs in man. In England the disease is mainly

found among those who work with hides and animal hair, such as tanners and wool-sorters. Infected shaving-brushes have accounted for a number of cases.

The anthrax bacillus is about the diameter of a red corpuscle in length, and in culture forms spores, which are extremely resistant to heat. Owing to its large size the bacillus is readily detected as a gram-positive rod in smears from lesions due to anthrax.

The most common form of the disease is a local infection of the skin known as a *malignant pustule*, occurring on exposed parts such as the face, neck, and arms, in those who handle infected material. The first symptom is itching, and in the course of a few days the lesion presents a characteristic appearance. In the centre there is a black slough or eschar due to effused blood; surrounding this is a ring of minute vesicles, and the whole lesion is encircled by a markedly indurated area; the neighbouring glands are swollen but do not suppurate. One of the most striking features is the absence of pain, as compared with a lesion of similar size due to pyogenic organisms. Often the patient feels quite fit for some days, but later fever and collapse indicate a septicæmia and the prognosis is extremely bad.

Diagnosis of Anthrax.—This is readily made on bacteriological examination. The occupation of the patient and the absence of pain in the local lesion are extremely suggestive, even when the pustule is not characteristic.

Treatment of Malignant Pustule.—Early diagnosis is essential. Selazo's anti-anthrax serum should be given intravenously as early as possible in doses up to 100 c.c. Intramuscular injection of serum should be repeated in smaller doses. Intravenous arsphenamine (0.5 to 0.9 grm.) and sulphapyridine have both been reported as of great value.

Pulmonary Form of Anthrax.—This occurs as the result of inhalation of infected material and is known as wool-sorter's disease. The symptoms are indefinite, and consist of a feeling of constriction in the chest, with cough and sputum. The diagnosis is made by the discovery of the anthrax bacillus in the sputum. Death is invariable.

GLANDERS

Glanders is a disease of horses, and is extremely rare in man. The causal organism is *Pfeifferella mallei*.

Human glanders occurs in two forms, acute and chronic.

In *acute glanders* the onset is sudden, with fever, malaise, headache, vomiting, and pain in the joints. These general symptoms are rapidly followed by nodular subcutaneous enlargements, known as farcy buds, which quickly ulcerate, the general picture is one of pyæmia. The disease in the acute form is invariably fatal.

In *chronic glanders* localised nodular enlargements appear on the skin, which ulcerate to form chronic ulcers with indurated edges. The disease may persist in a chronic form for many years but in some cases an exacerbation of symptoms occurs resulting in death from acute glanders. In chronic glanders abscesses must be opened and when possible the cutaneous lesions excised.

ACTINOMYCOSIS

Both local and general infections are sometimes produced in man by organisms of the fungus group which are known as the mycoses. None is common except actinomycosis which is caused by the *Streptothrix actinomyces*.

This disease occurs frequently in cattle, and it was formerly maintained that the streptothrix gained access to man through small abrasions around the lips or gums by direct inoculation from straws or grasses held in the mouth. More recently, however, the organism, which in man is anaerobic, has been shown to exist not uncommonly as a saprophyte in the mouth particularly in carious teeth.

The organism as seen in pus from an actinomycotic lesion consists of a mass just visible to the naked eye as a small yellow granule usually described as a "sulphur granule," the centre of which is formed by a mass of branching filaments with an outer layer of club shaped bodies. The filaments are gram-positive, but the clubs can be demonstrated only with difficulty.

The disease varies in its clinical manifestations according to the part of the body affected.

1 *The Jaw and Surrounding Structures*—This is by far the commonest site for infection in man, and probably accounts for well over half the cases encountered. The disease often starts with an injury such as an extraction of a tooth or a fracture of the jaw. In a fully developed case the affected area is indurated with numerous inflammatory nodules some of which break down and form abscesses discharging pus which may show typical sulphur granules. The disease tends to spread often with marked cicatrization of the older parts of

the lesion, and may extend down into the neck or upwards over the maxilla. Secondary infection with pyogenic organisms occurs frequently.

2. *Intestinal Type*.—Infection takes place presumably as a result of swallowing the streptothrix, which tends to lodge most commonly in the appendix, cæcum, or ascending colon. It may produce a close simulation of acute appendicitis, for which the appendix may be removed, and only recurrence of symptoms makes the diagnosis manifest. Sometimes the infection is more chronic and leads to the formation of a slowly growing mass in the right iliac fossa, which consists of adhesions and granulomatous material. Eventually the process involves the abdominal wall with the formation of fistulae, through which pus and sometimes feces are discharged. In the intestinal type of case the infection may reach the liver, which becomes the seat of multiple abscesses with considerable fibrosis. This gives a most striking appearance at autopsy, the liver resembling somewhat a sponge or honeycomb, the interstices of which are filled with pus.

3. *Lung*.—The infection may sometimes reach the lungs by direct spread from the neck into the mediastinum, but most of the cases in which the lung is involved appear to be primary, as the result of inhalation of the organism. Clinically, the cases closely resemble chronic pulmonary tuberculosis with cough, fever, and hæmoptysis. As in phthisis, there may be cavity formation, but, unlike phthisis, sinuses, usually multiple, form in the chest wall.

In severe cases a condition of pyæmia may be established by invasion of the blood vessels; metastatic abscesses containing the streptothrix form in any part of the body, such as the brain, muscles, or bones.

Course and Prognosis.—The disease is extremely chronic and may last for many years. The pulmonary and intestinal types are usually fatal, but when infection is confined to the jaw and neck there is often complete recovery. Severe secondary infection is an unfavourable feature.

Diagnosis.—In any condition around the jaw, in the chest or abdomen, which is associated with the formation of multiple and persistent sinuses, actinomycosis should be suspected. Sulphur granules in the pus are frequently not seen.

Treatment.—Abscesses and infected areas should be opened and drained. The only drug which appears to affect the disease is iodine, which may be given as potassium iodide in very large doses, up to 180 to 360 gr. a day, or as a 10 per cent. solution of iodine; 1 to 30 minims are given thrice daily in

milk. When the disease is localised in one area such as the jaw or the neck deep X ray therapy has produced great improvement. Possibly sulphonamido may be of value if much secondary infection is present.

RARE MYCOTIC INFECTIONS

Sporotrichosis—This is a condition caused by the fungus *Sporotrichum* producing small firm nodules on the skin which eventually break down and form abscesses. The lesions closely resemble those of syphilis and tubercle.

Aspergillosis—Pulmonary infection due to the fungus known as *Aspergillus fumigatus* occurs rarely and can only be diagnosed from tuberculous conditions by the discovery of the organism in the sputum.

PSITTACOSIS

In 1930 outbreaks in England and elsewhere brought this disease into prominence. The infection is primarily one of parrots but it is highly infectious to man. It is doubtful whether a patient with the disease can infect other human beings. The causal organism is a filterable virus.

After an incubation period of some ten days the patient becomes acutely ill with high fever and severe headaches. The condition soon comes to resemble that of the typhoid state. Pulmonary symptoms are often prominent and signs of patchy consolidation may appear. Sometimes there is an eruption of rose spots rather resembling those of typhoid fever. After two to three weeks the temperature falls rather abruptly and convalescence is slow.

The diagnosis rests on the history of contact with a sick parrot and the development of an illness resembling typhoid or an atypical pneumonia. Negative bacteriological findings as regards other diseases help to confirm the diagnosis.

There is no specific treatment and the mortality is usually about 20 per cent but varies considerably in different outbreaks.

J. J. CONYNGRAM

TUBERCULOSIS

PATHOLOGY

TUBERCULOSIS has been recognised from early times. Villenun proved it to be a transmissible disease in 1865 and Robert Koch isolated the bacillus in 1882.

The Tubercle Bacillus.—Tubercle bacilli belong to a class of organisms which stain with basic dyes and which do not easily lose their stain when treated with acids and alcohol—a property which permits this class to be distinguished from other organisms when films or slides containing infected material are stained by the Ziehl-Neelsen method. Several apparently stable types of tubercle bacilli have been isolated and classified according to their pathogenicity. Of these only the human and bovine types are known to cause tuberculosis in man, although related acid fast saprophytes occasionally appear in the sputum in cases of bronchiectasis and may thus cause difficulty in diagnosis.

The human tubercle bacillus is a slender rod, commonly slightly curved, and tends to occur in small groups in infected sputum. It is about $5\ \mu$ in length. Bovine tubercle bacilli are slightly shorter and thicker. Non acid fast granules derived from tubercle bacilli exist and may be demonstrated in sections of colonies of bacilli on artificial media, and also in healing lesions in human tissues. A controversy exists as to whether or not these granules are capable of giving rise to the organism again, and as to whether a life cycle of different forms of the bacillus really occurs. The organism is exceptional in many respects, thus for example its respiration is independent of changes in pH between the wide limits of 1.5 and 12. It is strictly aerobic, because it lacks the ability to induce glycolysis anaerobically. The respiration of cultures of the organism is proportional to the oxygen tension of the environment and the respiratory quotient of such cultures is constant whatever the level of the oxygen tension, moreover the oxygen saturation curve of the oxygen transferring ferment of respiration of the bacillus is very similar to the dissociation curve of oxyhaemoglobin.

Chemical analysis of tubercle bacilli has led to the isolation of constituent carbohydrates, lipoids, fats, and proteins. The lipid fraction is of particular importance because it varies sufficiently in kind and in concentration in the different types of tubercle bacilli, and in related saprophytic organisms, to permit identification by appropriate analysis, and also because it shares with the protein component of the organism the ability, on injection of producing the specific tissue reaction—that is the formation of tubercles—in both normal and previously infected animals.

Tissue Reactions—Infection by tubercle bacilli may produce various inflammatory tissue reactions. Of these necrosis, exudation and local cellular proliferation tend to take place early, though in any order or combination. They are in no way specific to the tissue in which they occur. Necrosis and the exudation of fluid, fibrin, leucocytes, and mononuclear cells are essentially similar processes in this, as in every inflammatory reaction. Local cellular proliferation includes the infiltration of the area concerned with macrophages and the formation of epithelioid cells, giant cells, and tubercles. In the lung the macrophages are typified by “alveolar phagocytes” whose origin is debated. The giant cells which have their nuclei arranged peripherally differ in this respect from those produced, for example, by the irritation of foreign bodies. Occasionally and characteristically these three reactions are together concerned in the formation of tubercles, which consist of epithelioid cells, lymphocytes, and reticulum, varying in quantity and arrangement but often concentrically placed about a core containing necrotic debris and one or more giant cells. Macroscopic tubercles are made up of aggregations of many microscopic tubercles such as the above, and appear as greyish white translucent small nodules.

Subsequent tissue reactions consist of caseation, liquefaction, fibrosis, calcification and occasionally ossification. Caseation is typical of tuberculous inflammation. It is preceded by fatty degeneration and necrosis of the tissue cells, and consists in the transformation of such tissue into a somewhat translucent uniform conglomerate. Since considerable areas of lung may be involved quite suddenly and since the process occurs at a time usually relatively distant from the moment of infection it has been assumed that a change in the allergy of the patient is an important causal factor. Liquefaction of a caseous area is accompanied by a rapid and considerable increase in the number of adjacent tubercle bacilli, and also by an active local vascular hyperemia. It seems possible that liquefaction, therefore, is a

show mainly exudative or mainly productive tissue reactions and so give rise to variations in the chronicity of the disease. The commoner less extensive multiple hæmatogenous lesions which usually appear soon after primary infection and are distributed towards the apices of the lungs as a rule are productive in character and tend to calcify (Simon's foci). Isolated large hæmatogenous foci (Assmann's foci) often become caseous with a variable subsequent fate.

Blood vessels veins but less commonly arteries are attacked by tuberculosis. The typical lesion is the intimal tubercle which differs in no essential of structure from the tubercle described above. The breakdown of such a tubercle may lead to the discharge of tubercle bacilli into the blood stream and so to the production of isolated or multiple hæmatogenous lesions or to generalised miliary tuberculosis. Tubercle of the wall of a vessel especially if supporting structures have been lost as in a pulmonary cavity may lead to aneurysm formation (Rasmussen's aneurysm). Tuberculous endarteritis is occasionally encountered. Lymphatic vessels apart from the important part they play in spreading the disease from an involved organ to the regional lymphatic glands where extension is common and thence possibly to the entire lymphatic system of the body or the blood stream are themselves not infrequently involved. The reaction in rare instances seems mainly to be productive and caseation does not occur, the vessel and adjacent glands becoming filled with proliferating cells of the endothelioid type and lymphatic stasis results. When such a lesion becomes widespread throughout the lungs the clinical and radiological appearances may closely resemble those of chronic (hæmatogenous) miliary tuberculosis.

Bronchi and bronchioles are not infrequently eroded by adjacent tuberculous lesions and so become choked with cellular and necrotic debris. Furthermore tuberculosis of the lungs may give rise to granulomatous bronchitis in which the lumen of the bronchus involved becomes progressively occluded by tuberculous granulation tissue and the structure producing consequences of fibrous tissue reaction. This process may extend to the trachea. Bronchial obstruction in this disease may also arise as a result of kinking arising from the anatomical changes produced by, for example pneumothorax or even extensive disease as a result of viscid sputum or blood, and especially in children by the compression of bronchi by enlarged mediastinal glands. Since bronchial obstruction from all these causes is common it follows that many different types of tuberculosis of the lungs are frequently and extensively

complicated by pulmonary atelectasis, and ultimately by bronchiectasis.

Tuberculosis of mucous surfaces throughout the body gives rise to the same tissue reactions. Granulation tissue however tends to be abundant while caseation and liquefaction lead to ulcer formation. On serous surfaces such as the pleura the inflammation may remain dry and the fibrous tissue reaction result in adhesions. Commonly, however there occurs an outpouring of clear effusion and cells in the exudative phase. In bone suppuration is frequent and may lead to the production of cold abscesses.

Allergy and Immunity—The tissue reactions to infection by tubercle bacilli are modified by the allergy and naivety of the individual infected. Thus at the site of reinfection the tissue reaction is intensified and accelerated as compared with the tissue reaction around a primary infection. Moreover this hypersensitive reaction in reinfected tissues is more rapidly followed by local disappearance of the bacilli and healing of the lesion. From this observation it was at first deduced that increased tissue activity was responsible for the production of antibodies and that in fact immunity and allergy in tuberculosis were mutually dependent phenomena. Since caseation and liquefaction were found to occur in association with relatively high degrees of allergy, and since both were harmful to the individual infected, an attitude of despair grew up in regard to immunological therapy—an attitude which was confirmed frequently by disastrous results in practice. Rich and his associates have however, experimentally been successful in dissociating allergy and immunity and have established the clinically important fact that it is quite possible to increase the latter without concurrently increasing the former. The use of tuberculin for this purpose is however still in the experimental stage.

Certain races as judged by their response to infection would seem to be relatively immune to tuberculosis—for example the Jews. Others for example the Irish the Eskimo and the Negro—have little racial immunity. A comparison of the subsequent morbidity from pulmonary tuberculosis of groups of uninfected and previously infected young adults exposed to the same risk of infection would suggest that tuberculous infection which has been overcome in the past confers some immunity on the individual. Furthermore the immunity of the uninfected individual has been successfully increased in France (in children) and in Norway (in nurses) by the use of BCG (vide p. 121).

Tuberculin Reactions—Tuberculin reactions have a limited diagnostic value in individual cases and they may also be used for example to survey the incidence of tuberculosis in a population. The reaction is specific and indicates that allergy to tuberculin has developed as a result of past or present infection. Though the intensity of the reaction is some measure of the degree of allergy it is not necessarily indicative of the activity of the disease. moreover many acute infections such as pyelitis or measles or even tuberculosis itself (miliary tuberculosis or extensive phthisis) may diminish tuberculin sensitivity. The reaction can most conveniently be observed in the skin and three tests—the von Pirquet (cutaneous) the Moro or patch test (percutaneous) and the Mantoux test (intracutaneous)—are available. The last is performed as follows. The skin on the flexor aspect of the forearm is cleaned with ether and 0.1 cc. of a 1 in 10 000 dilution of tuberculin (i.e. 0.01 mgm tuberculin) is injected intracutaneously. The skin is inspected from forty eight to seventy two hours later and a disc of induration more than 8 mm. in diameter around the site of injection is regarded as a positive reaction. If the reaction is negative or doubtful it may be repeated using a 1 in 1000 (0.1 mgm tuberculin) or later a 1 in 100 (1 mgm tuberculin) dilution of tuberculin until an undoubted positive reaction or the last dilution has been attained. Subject to the above mentioned limitation a negative reaction is strong evidence that infection by tubercle bacilli has not occurred.

PATHOGENESIS OF TUBERCULOSIS

Bovine tubercle bacilli ingested in infected milk cause a significant but small proportion of all cases of human tuberculosis. In this country where bovine tuberculosis is relatively prevalent from 25 to 40 per cent. of all cases of tuberculous meningitis and in children under five some 85 per cent. of cases of clinical lymphatic glandular tuberculosis are due to this cause. The total numbers of these cases however are relatively small and probably less than 1 per cent. of cases of pulmonary tuberculosis arise from this source. Preventive measures furthermore may ultimately eliminate this type of the disease for by 1938 bovine tuberculosis was entirely eradicated in Norway and it had become a great rarity in certain states in the U.S.A.—as a result of strict preventive measures.

Patients with phthisis who spray tubercle bacilli into the air on coughing or talking are the source of the great majority

of cases of tuberculosis. Thus in Germany (where bovine tuberculosis is common) more than 90 per cent of all primary infections occur in the lungs. Infected urine, feces or sinus discharges are by comparison of negligible importance.

Tuberculous infection sooner or later, develops in practically every individual in European and U.S.A. communities, indeed, the incidence of infection approaches 100 per cent in all classes at the age of forty, although below this age it is higher in every age group among the poorer than in the middle or upper classes. Primary tuberculous infection is now to a less extent predominantly associated with childhood than was the case at the beginning of this century and more persons reach adolescence or young adult life before becoming infected.

In the vast majority of individuals the infection is overcome and the various types of progressive tuberculosis do not develop, moreover, the mortality rates caused by the disease have in most civilized countries fallen very considerably in the last two generations. None the less the disease continues to be one of the worst scourges of humanity. In England and Wales for example about a quarter of a million cases of active tuberculosis were living and 25 872 deaths occurred from all forms of tuberculosis in the year prior to mid 1939, of which numbers more than four fifths were examples of respiratory tuberculosis. The war of 1914-18 was accompanied by a rise in the mortality from tuberculosis and it is significant that to mid 1940 and mid 1941 the corresponding death rates were 27,372 and 28 712—increases respectively of 6 and 11 per cent above the pre war level.

Our understanding of the factors which determine the development of progressive tuberculosis is incomplete. It is unknown for example if natural fluctuations in virulence of the organism occur. In animal experiments the severity of induced tuberculosis is within wide limits directly proportional to the size of the infecting dose. In man however, Chausse and Lange have shown that the architecture of the bronchial and bronchiolar system is such that only particles of $10\ \mu$ or less in diameter can reach the alveoli where infection takes place. Such particles could only contain one or perhaps two tubercle bacilli. Since it is known that one tubercle bacillus can give rise to tuberculosis and that the primary focus is single in almost every case it would seem probable that for this, the common natural mode of infection in man, the size of the infecting dose is immaterial though of course the likelihood of infection would probably depend on the frequency of exposure.

Whether reinfection occurs or not is uncertain. Thus pathological evidence suggests that reactivation of previously quiescent foci would account for the bulk of adult tuberculosis. On the other hand the high incidence of tuberculosis among doctors and nurses and members of enclosed communities such as nuns or sailors in all of which instances the chance of reinfection is high would suggest that exogenous reinfection is common.

The resistance of the individual to tuberculosis is probably modified by a variety of factors. Thus in primitive races the high early mortality of the disease may be due to the absence of an immunising childhood infection or more probably to the absence of the factor of selection which has long operated in races exposed to tuberculous infection. It is noteworthy that adult pulmonary tuberculosis occurs more commonly in those whose height is relatively great as compared with their thoracic circumference. This form of tuberculosis is also linked frequently with diabetes mellitus, siccosis and schizophrenia; it is relatively rare however for active pulmonary tuberculosis to be associated concurrently with any other infectious disease. The added burden and possibly the biochemical changes associated with pregnancy and its sequelae not infrequently are accompanied by the development or the exacerbation of pulmonary tuberculosis. The long recognised association of the disease with poverty and the rise in the mortality which occurred in the last war and which is again taking place to day would suggest that physical and psychological strain, poor living and working conditions, the increased employment of women and inadequate diet are significant etiological factors. That the last is particularly important would seem to follow from the fact that after a temporary fall an increase in the mortality of the disease coincided in Germany with the period of inflation in 1922 and 1923. The part played by such factors as leisure, fresh air, light and personal hygiene is difficult to estimate since they are largely determined by the standard of life of the individual which—as we have shown—in turn brings into operation other and probably more important consequences.

PRIMARY TUBERCULOUS INFECTION

The primary infection as compared with other tuberculous lesions presents unique features. Thus the corresponding lymphatic gland and its adjucent lymphatics are invariably

varies from four to eight weeks and the skin lesion develops as allergy to the primary infection and becomes demonstrable by tuberculin reactions

The proportion of primary pulmonary tuberculous foci which are demonstrable radiologically is unknown. Undoubtedly the commonest radiological abnormality associated with the lesion is enlargement of the mediastinal glands though considerable radiological experience is needed to dissociate pathological hilar glandular enlargement from the normal variations of blood vessel shadows ordinarily aggregated in this region. The appearance with time of calcification in these glands will confirm the diagnosis. The pulmonary component of the primary complex when visible commonly takes the form of an isolated often rounded homogeneous shadow (*rule* Plates 1 and 2). Quite frequently, too, the focus is seen to consist of a group of small flecks. The size of such foci when uncomplicated varies considerably but rarely exceeds an inch in diameter. Simultaneous hilar adenitis can usually be demonstrated. It is noteworthy that radiologically primary lesions are seen most often in the right lower and middle lung fields. As a rule the peripheral focus slowly calcifies though occasionally—and then usually shortly after its appearance—it may excavate and leave a thin walled cavity. In such cases tubercle bacilli may sometimes be demonstrable in the sputum or gastric residue frequently however these investigations are negative.

Epituberculosis—Commonly associated with the development of the primary complex in the lungs of infants and children is the complication which has been called Epituberculosis. Various hypotheses as to its pathological basis exist. Thus Rossle suggested that the lesion was constituted of the primary complex together with pulmonary atelectasis secondary to bronchial obstruction by enlarged caseous glands. On histological grounds the appearances have been described as a non-casating tuberculous pneumonia and also as an allergic tissue reaction dependent upon the aspiration of dead tubercle bacilli or the diffusion of tuberculo toxins following the erosion of a bronchus by the primary focus. On clinical and radiological grounds atelectasis would seem to be a probable component of the lesion. In a series of cases of epituberculosis in which bronchoscopy and measurement of the intrapleural pressure on the affected side were undertaken the author found that bronchial occlusion by compression or less commonly by caseous debris could frequently be seen while the intrapleural pressure was in every case unduly negative—a finding



PLATE 1—A Large Primary Focus in the Left Upper Lung
a secondary focus in the right lung

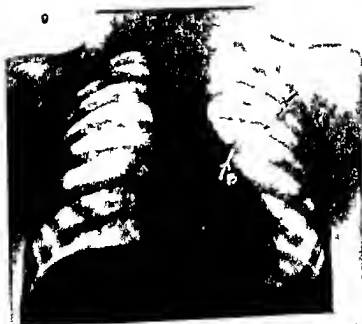


PLATE 2—A Primary (C) Focus of Tuberculosis (A) in the
Left Lung with Involvement of the Hilar Gland (n) Both
lesions show early calcification

[To face page 14]

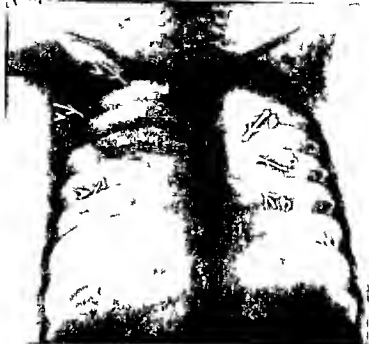


PLATE 3 —Epileptus is showing a Homogeneous Opacity involving the Right Upper Lobe (a) and Enlargement of the Mediastinal Glands (b) Atelectasis of the right upper and compensatory emphysema of the right middle and lower lobes is present

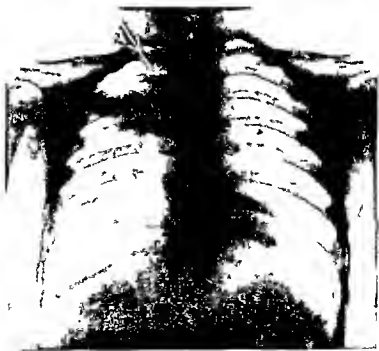


PLATE 4 Epituberculosis The same case four months later The opacity (a) in the right upper lobe has decreased in size and the mediastinal glands are much smaller Some atelectasis of the right upper lobe is still persistent

characteristic of atelectasis. Whichever of these hypotheses is correct, it is certain that the patient is allergic to tuberculin and presumably has some immunity, for the skin reactions are positive, and the infection is almost invariably overcome. Not infrequently tubercle bacilli can be demonstrated in the sputum or gastric residue, directly or after culture.

The symptomatology, like that of primary infection, may be inconspicuous though more often malaise, cough, pleuritic pain and irregular pyrexia of some duration are noticeable. Abnormal signs may be absent though when extensive areas of lung are involved impairment of movement, percussion note and air entry may be found together usually with some mediastinal displacement toward the affected side and sometimes bronchial breathing and riles over the area concerned. The radiological appearances (see Plates 3 and 4) consist of a diffuse and homogeneous opacity extending out toward the periphery of the lung from the hilum and it is sometimes possible to distinguish within this area the darker opacity of the peripheral caseous lung focus. The lesion is very frequently bounded by an interlobar fissure on one side commonly that between the upper and middle lobes on the right. Mediastinal displacement toward the lesion and compensatory emphysema are frequently apparent, as are enlarged hilar glands. With healing the opacity shrinks toward the hilum, the focus is exposed and may by now be showing calcification as may the hilar glands. While ultimately complete return to normality, a calcified complex or a residual fibrosis with localized bronchiectasis may result. It is probable that a considerable proportion of cases of bronchiectasis—especially apical bronchiectasis—originate in this way.

Treatment of Primary Tuberculous Infection—The increased examination of contacts to cases of adult type pulmonary tuberculosis and the development of mass radiological surveys of large sections of the population, has recently revealed and will continue to reveal a considerable number of cases of primary tuberculosis in the active stage. In the past the bulk of these cases have been untreated and the vast majority have satisfactorily overcome the infection, so that it would seem probably to be unsound to advocate institutional treatment for more than a selected proportion. Certainly where home conditions are satisfactory, and when continued medical (including radiological) examination is available there is much to recommend treatment in the home. Close observation is particularly important during the first twelve months after primary infection since during this period the majority of

disseminated tuberculous lesions, including bone and joint tuberculosis and meningitis, occur. Therapeutic research in primary tuberculosis is needed, but at present, apart from observation, the most valuable measures would seem to be regulated periods of rest, fresh air, protection from added infection, and an abundant mixed diet of high vitamin content. Cases of massive primary infection, epituberculosis, and the rare instances of multiple primary lesions are perhaps best treated in institutions, and children's sanatoria are most suitable for the majority. In those cases of epituberculosis in which the intrapleural pressure is shown to be unduly negative, it may be desirable to institute and maintain a temporary artificial pneumothorax in an attempt to prevent the development of bronchiectasis.

Disseminated Tuberculosis.—Two important processes of widespread dissemination of tuberculosis throughout the body exist for the bacilli may be carried in the blood stream, or via lymphatics. Both methods may, of course, be combined, thus, not only may lymphatic glands be infected from their own blood supply, but in the lymph the organisms may pass along the thoracic duct, and so into the subclavian vein.

Wilson estimated that tubercle bacilli could be cultivated from the blood in 5 per cent of cases of advanced pulmonary tuberculosis, in about 2 per cent of cases of non pulmonary tuberculosis, and in about 36 per cent of cases of miliary tuberculosis. Histological evidence suggests that the source of the bacillæmia is usually an incompletely healed or reactivated component of the primary complex—most commonly a caseous or liquefied mediastinal lymph gland—within or adjacent to which an initial tubercle on a vein breaks down. Direct arterial invasion is rare. As a consequence liberated bacilli as a rule are carried back to the lungs and there may be destroyed or give rise to secondary foci. An apparently quiescent primary complex may be reactivated and give rise to disseminated lesions after many years, occasionally, too, intermittent hæmatogenous dissemination takes place. Multiple hæmatogenous lesions from this cause more frequently occur in the first few months after primary infection. Individually somewhat rounded and small, they tend to be scattered symmetrically, they usually heal leaving a few fibroid or calcified scars (Simon's foci), and they are most often found toward the apices of both lungs. Isolated large hæmatogenous foci (Assmann's foci) (Plates 5 and 6) are less common, are often situated in the subclavicular regions of the upper lobes, and are less benign, since they usually caseate and not in-

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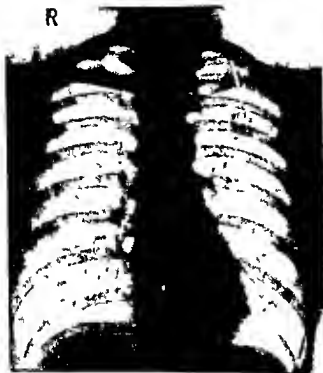


PLATE 1—A Secondary (Aspirin's) Focus of Tubercle,
(over the Left Subclavicular Region)

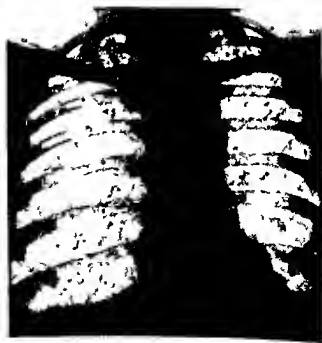


PLATE 2—Healed and Calcified Hematogenous Secondary
Lesions (Simon's Spots) In this case they are unusually
numerous but show predominant apical localization

frequently liquefy and cavitate. Though both the e types of hematogenous pulmonary secondary lesions may give rise to progressive phthisis they do not themselves as a rule produce symptoms or signs. Occasionally however cough productive of sputum which may contain tubercle bacilli sometimes hemoptysis and paroxysm with other symptoms of constitutional disturbance may occur. On the rare occasions when signs are detectable they are limited to localised adventitious sounds. Further evidence of activity in the lesions may be obtained from observation of the sedimentation rate or the von Bonsdorff count. Cases such as these in which evidence of activity is found need therapy based upon those principles which govern the management of phthisis (cfr p. 117).

If tubercle bacilli are liberated into a pulmonary vein or if following systemic venous dissemination organisms pass through the capillary circulation of the lung they will be scattered depending on their number more or less widespread throughout the body. Isolated or multiple foci may therefore develop if the local and general immunity is insufficient to overcome the infection. Certain sites seem more favourable for the development of progressive systemic tuberculosis than others. Thus for example the meninges and the central nervous system the eye bones joints the suprarenal and kidney the epididymis and fallopian tube and the intestines fairly frequently become diseased while muscles fascia and tendons are rarely if ever involved. Within the organs concerned the same series of tissue reactions which has been described takes place and their ultimate fate is bound up with the existing and resulting allergic and immunological responses of the individual. Every gradation from the most acute to the relatively chronic and ultimately healed lesions is seen. Reference should be made to the appropriate sections for further consideration of the various disorders which may result.

MILIARY TUBERCULOSIS

The hematogenous dissemination of a single fine suspension of tubercle bacilli may give rise to acute generalised miliary tuberculosis. Quite frequently and when the focus of dissemination is situated in a systemic vein the majority if not all of the lesions are situated within the lung. Often the lungs and other organs share the infection and rarely and presumably when a pulmonary vein is

whence the organisms are set free the lungs may be spared though other organs are heavily involved

The disorder occurs most frequently in children under ten and it is uncommon above the age of thirty. Quite often a history of close contact with an open case of phthisis can be obtained and when miliary tuberculosis occurs in adults it is not infrequently associated with chronic pulmonary tuberculosis or with tuberculosis of other organs. As a rule however the dissemination occurs during the first six months after primary infection. In acute cases the individual lesions—macroscopic tubercles—are predominantly exudative in type and since the consequences of meningeal involvement are disastrous meningeal symptoms often tend to overshadow those due to miliary tuberculosis elsewhere. It is worthy of note that in regard to tuberculous meningitis a curious localisation of the lesion tends to be present at the base of the brain particularly in the neighbourhood of the interpeduncular space and about the optic chiasma. Here beneath the thickened pia arachnoid a small amount of turbid exudate which often contains tubercle bacilli is to be found. On the membranes and along the arteries on the surface of the brain and within its folds it is often possible to demonstrate minute grey tubercles. Some degree of hydrocephalus with flattening of the convolutions from pressure is usually demonstrable. The cerebrospinal fluid which on lumbar puncture is comparatively clear as a rule but under an increased pressure if allowed to stand will produce a coagulum in which tubercle bacilli may be demonstrated. Before coagulation an increase of cells up to several hundred per cubic millimetre can be shown. Of these as a rule 70 to 80 per cent are lymphocytes though in the early stages higher proportions of polymorphs may be found. The protein content is increased from the normal of 30 mgm per 100 cc upwards to 300 mgm per 100 cc. Glucose is diminished or absent and the chlorides will be found to be below the normal level of 700 mgm per 100 cc.

Symptoms and Signs—Three classical types of miliary tuberculosis are described the typhoid the pulmonary and the meningeal. As a rule however individual cases rarely conform strictly to any one type but present features of all three with one dominant pattern. The onset is somewhat insidious and a vague history of general impairment of health and appetite of some weeks or even months duration may be obtainable. The early symptoms are most commonly headache vomiting constipation and a variable degree of pyrexia. Thus in children a gastro intestinal upset is usually suspected

while in adults influenza is commonly diagnosed. The persistence of the symptoms however and the continuation of the fever, rapid deterioration in the patient's condition with loss of weight, and then the onset of undoubted meningitis as a rule serve to show the grave reality. As there is great variability in the clinical picture outstanding symptoms and signs are perhaps best dealt with individually —

1 *Pyrexia* —Pyrexia is typically irregular, both in degree and duration. Usually wide variation between morning and evening temperature is shown and not infrequently "typus inversus" is seen—that is to say, a pyrexia in which the morning temperature on some days is higher than that of the evening. Hyperpyrexia occurs most commonly shortly before death. Occasionally from the onset the temperature rises slowly in a "step ladder" manner as in typhoid fever.

2 *Gastrointestinal Features*—Constipation and vomiting are common. The latter often occurs immediately after any food and is extremely intractable. Acetone can therefore frequently be smelt in the breath of these patients. Distension of the abdomen, in spite of constipation does not occur indeed, as the disease advances its surface usually becomes scaphoid. The tongue and mouth become dry, and fœdæ appear around the teeth and on the lips. Diarrhœa is rarely a feature. The spleen is usually enlarged but only occasionally to an appreciable degree in acute forms of miliary tuberculosis.

3 *Respiratory Features*—Dyspœa and cyanosis disproportionate severe as compared with physical signs in the chest are often found. The patient frequently has a cough which may be productive of small amounts of sputum which, unless phthisis is present only rarely contains tubercle bacilli. Scattered rhonchi and fine rales may be heard over the lungs. In addition, there may be evidence of chronic pulmonary tuberculosis.

4 *CNS Features*—Headache occurs early and is a dominant symptom, even before any other evidence of meningeal involvement is found. It is aggravated by movement and appears to be of great intensity. The patient may cry out at intervals even when semi-comatose. Another distressing feature of the disease is the grinding of the teeth. During the early stages irritative meningeal symptoms and signs are usually present. Thus the patient is restless complains of photophobia and if left alone tends to lie curled up on his side. The degree of neck retraction is usually less in tuberculous meningitis than in that due to other organisms. Neck rigidity however is commonly quite definite, and Kernig's sign is present.

Hypertonus in the limbs, with increased knee and ankle jerks and extensor plantar responses may be obtained. Later in the disease tendon reflexes are commonly diminished or lost, and may be absent from an early stage. Rarely examination of the fundi may reveal choroidal tubercles, while late in the disease papilloedema is frequently found. Cranial nerve paralyses are common, and the third nerve (squint, ptosis, and dilatation of the pupil) is often involved. In children generalised convulsions occur, and in older patients tremor and muscle spasm take place. Terminally flaccid paralysis and coma supervene.

5 *Cardiovascular Features*—Tachycardia from an early stage is typical while vasomotor instability is shown by the fact that a light scratch upon the skin produces marked local erythema and a wheal (*tache cérébrale*).

Differential Diagnosis—In the forms of miliary tuberculosis with prolonged pyrexia and no definite evidence of meningitis, the enteric group of fevers may be suspected. Apart from bacteriological and serological tests, however, typhoid fever commonly is accompanied by a relatively slow pulse, a fairly characteristic rash, an absence of vomiting, and a tendency of the headache to disappear after the first week. Moreover, in typhoid there is a definite leucopenia while in miliary tuberculosis a slight leucocytosis is common. The onset of meningeal symptoms is suggestive, and the identification of choroidal tubercles conclusive proof of miliary tuberculosis. Radiological examination of the chest in an established case, furthermore will reveal miliary foci in the lungs. In the meningeal forms there may be difficulty in the diagnosis from meningitis due to other organisms, or from a cerebral abscess or tumour. The posterior basic meningitis of infants is most common before the age of one and during this period of life miliary tuberculosis is uncommon. Careful examination of the cerebrospinal fluid is diagnostic, in that the organism concerned can usually be identified with certainty. Moreover, in tuberculous meningitis the increase in cells is commonly mainly lymphocytic, while in pyogenic meningitis the cells are mainly polymorphs. Sometimes encephalitis lethargica or anterior polio myelitis may be suspected, but in both these conditions the increase in cells in the cerebrospinal fluid is commonly less marked than in tuberculous meningitis, and the subsequent course entirely different. Careful examination of the tympanic membranes is essential, since the early stages of sinus thrombosis or meningitis arising from middle ear disease may give symptoms somewhat similar to miliary

tuberculosis. It is worthy of note that the tuberculin skin reactions are of little or no help in diagnosis, since they are commonly negative in miliary tuberculosis.

Prognosis—In almost every case the disease is fatal and the duration of life from the onset of the symptoms varies from a few days to a few months. Very occasionally cases which run a subacute or chronic course are encountered, and isolated instances of recovery from miliary tuberculosis are on record.

Treatment—Palliative therapy consists in the relief of headache by frequent lumbar punctures, the exhibition of sedatives, including morphia, and the employment of such comforts as a darkened room, an absence of noise and of disturbance of the patient are all important. Persistent vomiting may make nasal feeding necessary. No measure is known to make any major difference to the progress of the disease.

Chronic Miliary Tuberculosis—Hoyle and Vasey have recently described a group of cases in which evidence of miliary tuberculosis was obtained and in which the patients lived for more than six months. Occasional cases apparently healed their lesions and recovered. The outstanding features of the disease were the following: Prolonged irregular toxæmia with recurrent phases of pyrexia associated with sweating, anorexia, loss of weight, amenorrhœa, cough, and sometimes pleuritic pain. Splenomegaly, generalised enlargement of lymph glands, tubercles of the skin, iridocyclitis, cystic changes in the small bones of the hands and toes, and occasionally uveo-parotitis are all variously found. The radiological appearances within the chest may show a distribution of foci similar to that in the common acute form of the disease. Not infrequently, however, the appearances suggest gross mediastinal lymphadenitis together with a reticular shadowing spreading out throughout both lungs. When death occurred in these cases, it commonly did so after many months of toxæmia, and post mortem findings were those of generalised disseminated tuberculosis. It is very often extremely difficult to demonstrate tubercle bacilli in these cases and so, in life the diagnosis often remains a matter of some doubt. Moreover, conditions such as sarcoidosis, miliary leukemic deposits, and silicosis may on occasion give somewhat similar clinical or radiological features.

Therapy is palliative and symptomatic, but should be associated in every case with prolonged rest, abundant good food, and, if recovery seems possible, a sanatorium regime at a later stage.

is exerted peripherally upon its walls by the elastic retraction of the surrounding lung tissue. If the bronchial opening becomes partly occluded by debris or by kinking and so permits air to enter the cavity on inspiration more easily than it allows egress on expiration rapid increase in size of the cavity will take place until the partial obstruction is overcome or becomes complete. In the latter case air is slowly absorbed into the blood stream and the cavity tends to close. Fluctuations in size not uncommonly take place fairly quickly. Permanent closure of the cavity may follow in this way or sometimes may take place if it becomes entirely choked by caseous debris while uncommonly epithelialisation of its walls takes place with healing of the tuberculous process and a functional bronchiectatic excavation remains. More commonly however than any of these in an untreated case the cavity persists bacilli are aspirated into adjacent areas of the lung and the disease slowly extends. Healing reactions may take place or may be interrupted by fresh bronchogenic or haematogenous spread. Commonly a slow irregularly progressive extension of the disease throughout both lungs is seen. In such cases associated tuberculous lesions of the larynx and of the intestines take place by direct spread of infection in sputum coughed up from the lungs. Not infrequently also especially in advanced cases amyloid disease develops involving as a rule the spleen liver kidneys or intestines.

At autopsy in a typical advanced case the body is emaciated on opening the thorax the visceral and parietal pleurae are found to be more or less adherent. Adhesions between the lobes are always found and the pleura at the apices is usually thickened. The affected areas of lung are diminished in size and the remainder is enlarged by compensatory emphysema. The heart is small and displaced towards the more shrunken lung. The lungs themselves, often greatly disorganised may contain little tissue capable of physiological function. They show in different parts the various changes associated with old and recent disease, *i.e.*, fibrosis caseation, cavitation healed calcified foci and areas of broncho pneumonia.

Classification—In the British Isles the classification in use is that suggested by the Ministry of Health in 1930. Four groups are separated as follows—

Grade A Cases in which tubercle bacilli have never been demonstrated in the sputum, pleural fluid, faeces, etc.
Grade B Cases in which tubercle bacilli have at any time been found. This Grade is subdivided into three subgroups.
Grade B1 Cases with little if any constitutional disturbance,

exhibiting limited physical signs and having no complications (tuberculous or other) Grade B3 Cases with marked constitutional disturbance, severe impairment of function, either local or general and with little or no prospect of recovery This grade includes all cases having grave complications, such as diabetes mellitus tuberculous enteritis, etc Grade B2 All cases which cannot be placed in Grades B1 or B3

Tuberculous Surveys—Investigation of the apparently healthy has shown that in this way only may we hope to diagnose pulmonary tuberculosis in its earliest stages, when therapy is most effective in a high proportion of cases, for the disease at its onset and for long thereafter may cause no noteworthy symptoms The available methods in use include tuberculin reactions the significance of which has been discussed, photoradiography and radiography Photoradiography is economical and time saving and will probably be used increasingly for large sections of the population Quarterly or half yearly re-examination is desirable, and when any abnormality is disclosed full investigation is essential

Early Symptoms—The onset of pulmonary tuberculosis may be insidious, or it may be characterised by striking symptoms which the most unobservant patient cannot overlook It is commonly stated that the cases presenting a sudden onset are those with the best chance of recovery, one reason for this is that they submit themselves for treatment at a much earlier stage of the disease It is therefore most important that these early symptoms should be recognised in their true significance by all medical practitioners A common mode of onset is an acute transient febrile illness accompanied by respiratory catarrh and malaise the illness resembling influenza The most outstanding of these early manifestations of the disease are hæmoptysis and pleurisy These are also common in the later stages of the disease, but their value in diagnosis arises from the fact that they sometimes occur months before any other definite symptom of pulmonary disease and long before the lesion in the lung is sufficiently extensive to present physical signs or to be discoverable by X ray examination

HÆMOPTYSIS—This is the first symptom in about 10 per cent of cases of phthisis In its most characteristic form it occurs as a sudden free hæmorrhage "out of a blue sky" The patient, while apparently in perfect health may one day feel warm fluid in his mouth and expectorate perhaps as much as half a pint of bright red blood During the succeeding twenty four hours he coughs up clots of darker blood mixed with mucus, thus demonstrating that the site of the bleeding

the lungs. Such an event demands the fullest investigation and close observation. Hemoptysis occurs in a variety of conditions, but only in early phthisis do we get sudden and profuse bleeding in a patient who is apparently well and who has no other symptoms of cough, expectoration, or dyspnea.

Pleurisy—Pleural effusion in an adult must be regarded as indicating tuberculous disease of the lung in the absence of some other demonstrable cause such as cardiac or renal disease. The fluid in tuberculous pleurisy is clear, sterile, and contains lymphocytes.

Dry pleurisy is of less significance and is often non-tuberculous. It is, however, a frequent forerunner of phthisis. In tuberculous cases it is usually recurrent and accompanied by pyrexia, which subsides when the patient is confined to bed but recurs when he is allowed up.

Even in the absence of the dramatic symptoms noted above, careful analysis of the complaints of the patient will often enable us to diagnose the disease at a very early stage. The characteristic symptoms are: (1) excessive fatigue—the patient is exhausted by an ordinary day's routine which he could hardly accomplish without discomfort; (2) loss of weight—this may not be rapid but it is continued, and after a few months will be noticed by his friends; (3) failure of appetite—many cases the patient will state that his appetite is good, when asked what he eats for breakfast he will almost invariably admit that he has no desire for food in the mornings. Amenorrhoea—in young women irregularity or cessation of menstruation is a very common symptom of early phthisis; excessive sweating, the most characteristic example is the night sweat which occurs during deep sleep in the early hours of the morning and involves the whole of the skin area; equally common in early phthisis is axillary hyperidrosis, which occurs during the day and soaks through the clothes in the arm pit even during the coldest weather.

The above symptoms are of toxic origin. The early pulmonary symptoms are cough and expectoration. These do not arise during the early stages of the disease. The more important symptom is expectoration, if this continues for a number of weeks in a young adult it should arouse suspicion of tuberculous disease. Repeated microscopic examinations of sputum are essential and should if necessary be supplemented by culture or guinea pig inoculation.

Physical Signs of Early Phthisis—*Pyrexia*—This is one of the most important signs of early tuberculosis. Observation of the temperature curve while the patient is up and about will

show an abnormal diurnal variation in a majority of cases. The temperature may be recorded in the mouth or the rectum. Mouth readings are reliable if taken with care in patients who are not dyspnoeic and who are not mouth-breathers. In phthisical patients it will often be found that the morning temperature is unnaturally low, and that during the afternoon or evening it rises above normal to the extent of half a degree Fahrenheit or more. In women undue attention should not be paid to records taken during the week preceding menstruation, as many healthy women show a slight rise of temperature at that time.

Tachycardia.—The pulse-rate is almost invariably quickened in early phthisis, even when the patient is apyrexial. A pulse rate persistently below 80 beats per minute is presumptive evidence against a diagnosis of progressive tuberculosis.

Signs in the Chest.—It is of the first importance to emphasize that in its early stages pulmonary tuberculosis is usually accompanied by no abnormal physical signs in the chest, and consequently radiological and other investigations should never be withheld in cases where the symptomatology is suggestive because the lungs appear normal to routine physical examination. However, on inspection wasting of muscles over the base of a diseased apex may be found. The muscle most affected is usually the supraspinatus; the spine of the scapula will stand out with undue prominence on this side. Later in many cases there is also falling in of the soft parts above and below the clavicle. Diminished movement of the upper chest may also be detected.

Light percussion may reveal impaired resonance at the apex of the lung. The note obtained over corresponding points on the two sides should be compared while the patient holds his breath with the lungs fully inflated. The most important situations for percussion in front are above the clavicles, below their outer thirds, and direct percussion on the shafts of these bones. Posteriorly the apex should be percussed over the first and second interspaces. In normal subjects it is not uncommon to find the right apex less resonant than the left in front, but any such difference over the posterior aspect of the upper chest is of pathological significance. Impairment of resonance is sometimes met with at an early stage of the disease at the top of the axilla, or in the region between the vertebral column and the inner border of the scapula.

Auscultation.—It is rare to hear tubular breathing in early phthisis, but in the neighbourhood of the lesion the breath-sounds are usually feeble. During ordinary breathing

no added sounds may be audible, but accompanying or immediately after a cough crepitations or fine râles are often to be detected.

The spoken voice will be conducted normally, pectoriloquy will only be obtained with a considerable area of consolidation or a cavity and is not therefore an early sign.

Symptoms and Signs in Later Stages—In the later stages the toxæmia is shown by a hectic swinging temperature which may range from 97° F. in the morning to 102° F. at night. Moreover, the pyrexia which at first was only present when the patient was up can no longer be subdued even by prolonged rest in bed. The body is wasted the cheeks flushed the eyes bright and sunken the lips dry. Atelectasis and fibrosis is shown by retraction of the chest wall and by displacement of the trachea and cardiac impulse. The fingers may be clubbed the nails being thin and dull in these respects differing from the very thick polished nails seen on the clubbed fingers of the bronchiectatic. The breath has a peculiar stale sweetish odour not grossly offensive as in lung abscess. The sputum is copious purulent and nummular i.e. it floats in separate rounded lumps in the sputum cup. Dyspnoea and cyanosis may be well marked.

The voice may be husky and the bowels loose as a result of extension of the disease to the larynx and ileum respectively.

As the disease advances weakness and languor increase, the appetite does not fail completely, but it becomes capricious and the patient feels a craving for unusual and highly seasoned dishes. Sleep is disturbed by the frequent cough and copious expectorations, also by profuse night sweats. The mentality remains clear to the end, and the patient complains little unless he be tortured by the pain of severe laryngeal ulceration. There is often an unnatural sense of well being and hopefulness of recovery, the *spes phthisica* of the older writers.

On examination of the chest, besides the retraction of the upper parts of the thoracic wall and displacement of the mediastinum immobility over the diseased areas of lung will be noted. Over extensive infiltration movement and air entry is often restricted expiration prolonged and râles and rhonchi may be audible especially after coughing. Consolidation is characterised by impaired resonance bronchial breathing pectoriloquy and crackling râles. Fibrosis and atelectasis by poor movement and air entry impaired percussion note and mediastinal displacement toward the affected side. Over a cavity characteristic signs may be obtained if it is both large and superficial. In these circumstances tympanitic

Modes of Death.—A fatal termination is most common brought about by a gradual failure of strength, the result poisoning by the toxins of the tubercle bacilli and of increasing impaired respiration. Hæmorrhage is not often the immediate cause of death, but rupture of an aneurysm in a tubercular cavity brings some cases to an abrupt end, the patient drowning in his own blood.

Not infrequently death is due to extension of the disease to other organs; ulceration of the larynx with severe dysphagia may prevent the swallowing of food, ulceration of the intestine may cause exhausting diarrhoea, or the entry of bacilli into the blood stream may lead to miliary tuberculosis.

OTHER VARIETIES OF PULMONARY TUBERCULOSIS

Fibroid Phthisis.—As the name implies, this variety of the disease is characterised by the formation of much fibrous tissue in the affected areas of the lungs, sometimes with atelectasis. The diseased areas are shrunken, the pleura



PLATE 7—Chronic Pulmonary Tuberculosis. Extensive fibrosis and excavation of the right upper lobe has occurred and there has followed a secondary spread into the middle zone of the left lung.

resonance may be obtained in the centre of an area of dullness, with amphoric breath sounds and crackling rales. Whispering pectoriloquy is strikingly obvious and not infrequently it sounds as though two persons were whispering in unison on a sign known as "echoing pectoriloquy." With small cavities or even large ones that are not superficial these characteristic signs are absent and only those of surrounding infiltration or fibrosis may be obtained.

Course—The progress of a case of chronic ulcerative tuberculosis is usually one of alternate remissions and exacerbations. Adequate treatment in the early stages may bring about quiescence and arrest of the disease, but even while under treatment serious relapses occur sometimes apparently dependent on undue exposure to the sun's rays, sometimes associated with an indiscreet resumption of increased muscular exercise, long hours of work, and the like. Most frequently, however, no cause can be found to explain the relapse. After the disease has been arrested it may again become active as a result of other diseases, of an unhygienic mode of life or of any factor which lowers resistance and in women one of the common causes of reactivation is pregnancy. On the other hand there are many cases in which the disease though never arrested dies down to a low grade of smouldering activity for months or years at a time. During these periods of remission there may be no pyrexia and little toxæmia although the sputum may be crowded with tubercle bacilli.

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PLATE 8—Tuberculous Pneumonia involving nearly the entire Right Lung. Excavation is just beginning at A.



PLATE 9—Senile Phthisis, showing extensive Bilateral Infiltration and Fibrosis with little or no Excavation.

[To face page 117.]

thick and adherent, and elsewhere the lungs are enlarged by compensatory emphysema. The heart and trachea are displaced toward the more fibrosed lung. Physical examination reveals clubbing of the fingers, retraction of the chest wall, displacement of the cardiac impulse, and all the usual signs of fibrosis in the regions affected. The disease runs a very chronic course with little pyrexia or constitutional disturbance. The patient is dyspnoeic on exertion and may develop tuberculous tracheo bronchitis. Repeated haemoptyses are common. After many years of slight ill health the end may come fairly quickly as a result of heart failure, lardaceous disease or tuberculous meningitis.

Tuberculous Pneumonia—Tuberculous pneumonia is an common evil in young subjects. The disease often proceeds to a fatal termination in a few weeks or months without any of the remissions characteristic of the chronic forms. In the lungs the changes may take the form of an exscenting lobar pneumonia with which there is little protective formation of fibrous tissue (see Plate 8). In other cases the pathological changes are those of broncho pneumonia with patches of consolidation scattered over both lungs. In the latter type the physical signs are at first those of a diffuse bronchitis, tubular breathing and crackling rales give evidence of areas of consolidation after a week or two. Liquefaction with excavation is common in each form. Broncho pneumoniaic phthisis not infrequently follows a brisk haemoptysis.

Symptoms—There may occur a prodromal stage of vague ill health lasting several weeks then a sudden exacerbation with chill fever pain in the chest and cough. The patient is forced to remain in bed by weakness and dyspnoea. Sustained or remittent high pyrexia occurs together with rapid emaciation. The sputum may at first be frothy and blood stained but it soon becomes green and nummular and swarms with bacilli. In the great majority of cases death results from toxæmia within a few months and the disease is not usually improved by collapse therapy.

Senile Phthisis—Pulmonary tuberculosis is quite common in elderly subjects and is a frequent cause of death in inmates of almshouses and other institutions for the aged. The course is usually slow, but no treatment is effective in arresting its progress. Both the symptoms and the physical signs are often masked by accompanying bronchitis and emphysema. Fairly typical X ray appearances are shown on Plate 9.

Complications of Pulmonary Tuberculosis—*Secondary Infections*—The diseased areas in the lungs become invaded

by septic organisms, and if cavities are present the toxæmia from these secondary infections may overshadow the symptoms due to the original tuberculous disease. The organisms commonly found are the *Staphylococcus aureus*, pneumococcus, and streptococcus.

Lungs—Not infrequently massive collapse of a lobe, or even of a whole lung complicates pulmonary tuberculosis. In such cases the paucity of the symptoms, and the relatively chronic course of the disease, contrasts strongly with the apparently gross physical signs and striking radiological appearances. The sputum in such cases as a rule persistently contains tubercle bacilli. Bronchiectasis far more frequently complicates phthisis than is usually suspected.

Pleura—The pleura never escapes inflammatory change, and in the majority of cases there are found thickening at the apex and adhesions uniting the lobes of the lung to one another, and attaching them to the chest wall. Rupture of a focus in the lung into the pleural cavity may cause spontaneous pneumothorax, hydro pneumothorax, or tuberculous empyema.

Infection of Tissues by Sputum—The passage of infected sputum may lead to tuberculous ulceration of the larynx or of the tip of the tongue. If the sputum is swallowed the infection will be carried down the alimentary tract, and may cause intestinal tuberculosis. The Peyer's patches of the ileum will be chiefly affected.

Fistula is and is very often secondary to pulmonary tuberculosis, and is of special interest, as it is a complication which may occur early in the disease, sometimes long before the patient is aware that he has a lesion in the lung.

Metastatic Complications—Tubercle bacilli in the blood stream may give rise to general miliary tuberculosis, or may lead to the formation of tubercles in, for example, the central nervous system, pericardium, endocardium, kidney, epididymis, suprarenals, or one of the larger joints.

Lardaceous Disease—The prolonged toxæmia may cause amyloid degeneration of the solid viscera or bowel. Clinical evidence of this complication appears as œdema, diarrhoea, profuse albuminuria, and enlargement of the liver and spleen.

Prognosis—There is no disease in which prognosis is more difficult, and there is an old saying that "he who attempts to forecast the outlook may be sure of one thing only, that he will be mistaken." Autopsy experience shows that the disease may heal at almost any stage. There are, however, certain factors which help us to form an estimate as to the chances of recovery, or, failing this, of the probable duration of life.

Type of Disease—The pulmonary form of acute miliary tuberculosis is as a rule fatal and tuberculous pneumonia almost equally hopeless. In the other types the cases in which there is a predominance of fibrotic change are more hopeful than those in which there is much caseation and cavity formation. The disease may become arrested and even health may be maintained for years in spite of considerable cavitation.

Extent of Damage in the lungs is not a reliable guide to prognosis, the rate at which the destructive process advances is of much greater significance.

Toxæmia—Pyrexia not quickly subdued by rest in bed is of grave import, as is tachycardia, even without pyrexia.

Age and Habits of the Patient—An unfavourable course must be expected if the onset occurs below the age of eighteen or above that of fifty years. Effective treatment and after care may be impossible if the patient is of an impatient temperament or low intelligence or if his financial resources are insufficient to provide adequate rest and nourishment. Alcoholism is always a most unfavourable feature.

Presence of Complications—Ulceration of the larynx or of the bowel add very greatly to the gravity of the outlook in any stage of the disease but do not make it necessarily hopeless. Diabetes mellitus, silicosis and pregnancy tend seriously to aggravate the disease.

Diagnosis—It is of the utmost importance that pulmonary tuberculosis should be recognised in its early stage. The chance of arresting the disease may be irrevocably lost if treatment is delayed for several months. Unfortunately, early and effective treatment is applied in only a small proportion of cases. The reasons for this tragic delay are twofold: firstly, because the onset is often insidious and patients do not seek advice until the disease has become firmly established, secondly, because practitioners wait for the appearance of physical signs in the chest before committing themselves to a diagnosis.

If the onset is heralded by dramatic symptoms such as hæmoptysis or pleurisy, the practitioner should have the moral courage to inform his patient of the possible nature of the condition in spite of the absence of confirmatory evidence. When the onset is insidious the diagnosis is based on a careful analysis of the symptoms and history. Absence of a history of contact with the infection is of no significance. Confirmation is sought in observations on the daily range of temperature: afternoon pyrexia may be present only if the patient is allowed to take exercise. It is characteristic of tuberculous toxæmia

that a brisk two-mile walk will raise the temperature a degree or more Fahrenheit, and that it will not subside to normal within thirty minutes.

The most satisfactory proof of the diagnosis is the demonstration of tubercle bacilli in the sputum. If the first examination is negative, it should be repeated several times, and attempts should be made to culture the organism; in cases where there is no expectoration, the bacilli should be searched for in the gastric residue.

In occasional cases, especially of apical disease, physical signs may be present before the lesion is demonstrable by X-ray; far more frequently the reverse is true. In every case in which pulmonary tuberculosis is suspected *adequate radiological examination of the chest is essential*. Such an examination is equally necessary as a guide to treatment once the diagnosis has been made.

The common appearances of pulmonary tuberculosis in X-ray photographs are: (1) Infiltration, which takes the form of fluffy opacities with ill-defined margins localised or scattered over the lung fields without apparent relation to the arrangement of the vessels or bronchi; (2) Cavitation, which is seen as a more or less dense ring-shadow, the lower part of which may show a "fluid level"; (3) Larger confluent opacities of varying size, (4) Fibrotic strands, or thickened pleura; and (5) Lobar, or lobular atelectasis, with mediastinal displacement.

Tomography will show that the bulk of the lesions are situated posteriorly and may help in the localisation of cavities.

None of the physical signs elicited by examination of the chest are diagnostic of pulmonary tuberculosis. However, abnormal signs in the apical or subapical regions are suggestive and help to confirm other evidence.

Active and Inactive Pulmonary Tuberculosis.—The presence of tubercle bacilli in the sputum is certain evidence of activity. In the absence of such a finding active disease may be presumed if (1) radiological evidence of pulmonary tuberculosis exists and, in addition, any one or more of the following are present; (2) undoubted symptoms and signs of active disease, *e.g.*, pyrexia, loss of weight, anorexia, night sweats, etc.; (3) otherwise unexplained persistent elevation of the sedimentation rate; (4) altering tuberculous radiological appearances on serial examination particularly if fresh infiltration or excavation should appear.

Differential Diagnosis.—A variety of conditions may be mistaken for pulmonary tuberculosis, both in its early and later stages.

Atypical pneumonia may simulate pulmonary tuberculosis clinically and even radiologically, but usually the diagnosis becomes clear if the patient is kept under observation.

Hyperthyroidism simulates early phthisis in toxic symptoms such as tachycardia, loss of weight and amenorrhœa, but does not cause the remittent pyrexia of phthisis.

Hæmoptysis is common in *mitral stenosis*, *bronchiectasis*, *lung abscess*, and *pulmonary neoplasm*.

Clubbing of the fingers with pyrexia and tachycardia may be due to *subacute bacterial endocarditis*. Malaise, pyrexia, tachycardia and loss of weight are associated with some generalised infections such as undulant fever and also sometimes with focal sepsis of obscure location.

In almost every case of chronic pulmonary tuberculosis repeated examinations of the sputum will reveal tubercle bacilli, elastic fibres may be found in the sputum in cases of pulmonary tuberculosis and pulmonary suppuration.

TREATMENT OF PULMONARY TUBERCULOSIS

Our aim in treatment is to diminish the toxæmia and to increase the patient's natural powers of resistance so that the infection may be subdued and the pulmonary lesions may be securely healed. If the disease is already so advanced that there can be no reasonable hope of obtaining complete arrest palliative treatment only should be prescribed. If however the disease is still in an early stage the position should be frankly explained to the patient and his co-operation should be obtained so that a whole-hearted effort may be made to obtain a successful and lasting result.

Treatment of the Early Case—As soon as the diagnosis has been made, the patient should be confined to bed for a period of complete rest. Four weeks may suffice if there is no pyrexia but if the temperature is raised he must lie still in bed until apyrexia and for a further period of three or four weeks after. This rest period may be carried out in the patient's home in a well ventilated room under the supervision of a trained nurse. No restrictions are placed on diet except as regards alcohol, small quantities of food should be given every two hours through the day, and the regime should include abundance of milk, butter, and raw fruit. A teaspoonful of cod liver oil is given three daily throughout the whole period of treatment and during the winter months for several years after. If the patient is in bad financial circumstances, or the home conditions

are otherwise unsuitable, he must be placed in a hospital. He should not be in contact with young children.

Rest should be modified thereafter by permitting gradually such activities as washing, shaving and later visits for toilet purposes to the closet or bathroom. The duration of rest should depend solely upon the evidence which each case presents that the pulmonary lesions are healing and will usually continue long after the patient feels quite well.

The blood sedimentation rate is of great value in assessing the activity of the disease. All exercise should be forbidden until the sedimentation rate is reduced to normal limits.

Sanatorium Treatment—The suggestion of sanatorium treatment is commonly met by objection on the part of the patient or his relatives. They require reassurance on two points: firstly, may not residence at a sanatorium stamp the inmate as a consumptive and render him an object of dread for the rest of his life; secondly, when at the institution will he mix with patients in a more advanced stage of the disease from whom he may contract a more virulent infection. Neither of these suppositions is correct. Sanatoria do not broadcast the names of their inmates; moreover, notification of all cases of active tuberculosis is the statutory duty of every practitioner whether the patient goes to a sanatorium or not. As regards the second point a patient who is suffering from the disease is believed to be relatively immune to reinfection.

Choice of Sanatorium—Before recommending a sanatorium, the practitioner should be satisfied that the staff are efficient and conscientious. Provided that careful skilled observation be exercised, the situation and climatic conditions are of secondary importance. There is a popular belief that some mysterious healing property is to be found in the air of the higher altitudes in the Swiss Alps. Experience does not confirm this tradition, and it is wiser to avoid long journeys when arranging the treatment of a "curable" case.

General Principles of Sanatorium Treatment—Throughout his stay in the sanatorium the patient is kept under close observation as regards the diurnal range of temperature and pulse rate, and his response to exercise. The weight is recorded each week, and examinations are made of the sputum, the physical signs, blood sedimentation rate and radiographic appearances of the lungs. He is gradually inured to an outdoor existence and he should be allowed up for increasing periods provided there be no evidence of activity in his lesions. He is permitted to take more and more exercise and finally trained to undertake manual labour. If for example py—

at any time, he is given another period of complete rest, and when the temperature and sedimentation rate remain normal he is worked up through the various grades of physical exertion again.

He is educated in a strict routine which he is to follow for the rest of his life. This includes intolerance of unventilated rooms, avoidance of heavy clothing both by day and night, regular periods for rest and meals, avoidance of hurry, fatigue, and excitement. If there is sputum he is taught to dispose of it in such a way that it may not be a danger to others, and he is trained not to swallow it lest it should infect his own alimentary tract.

After Care—On leaving the sanatorium the patient should be kept under regular clinical and radiological observation for several years. If he is a wage earner he must be advised as to possible modifications of his work in order that he may avoid long hours and periods of stress without reducing his earning capacity to the level of poverty. A change of employment from a sedentary occupation to laborious work out of doors is seldom advisable. Female patients must be warned to avoid the risk of pregnancy until to every available test the disease has been arrested for four or five years.

Accessory Methods of Treatment—If toxæmia cannot be controlled by complete rest in bed, if the disease is advancing rapidly, or if relapse takes place during or shortly after the routine measures just described, other methods must be employed. The most effective of these are described under the term "collapse therapy."

COLLAPSE THERAPY—The principle underlying this treatment is comparable with the usual method of dealing with tuberculous arthritis. One of the first principles of the surgeon in treating a tuberculous joint is to secure immobilisation of the inflamed parts. The lungs are constantly moving and being stretched by respiration, and this continual movement of the inflamed and ulcerated lesions impedes the reparative processes and carries infected material from one part of the lung to another. It is possible to immobilise the diseased areas of the lungs without unduly reducing the functional efficiency of the remainder.

Collapse therapy is indicated in most cases in which the tuberculous disease is confined to one lung and a prompt response is not obtained to routine sanatorium treatment. It should be employed in all unilateral cases if there is cavitation or if there are complications such as tuberculous laryngitis or pregnancy. In general this treatment must be modified or not undertaken if there is (1) radiographic evidence of active

disease in the opposite lung, (2) dyspnoea when at rest generalised emphysema or other evidence of a seriously diminished respiratory function

Immobilisation of the lung is achieved by inducing an artificial pneumothorax i.e. introducing air into the pleural cavity. The lung is gradually collapsed by periodical injection of sterile air and the collapse is maintained by further refills for a period of three or more years. In experienced hands the dangers are not greater than those of other minor operations and the results have been good. The treatment can be continued while the patient is engaged in active work. Complete arrest of the disease has been obtained in many cases in which the ordinary constitutional treatment had failed. Satisfactory results however must not be anticipated from unilateral pneumothorax unless the method be employed only when a *ray* examination shows the better lung to be still free from extensive disease.

Bilateral artificial pneumothorax is sometimes employed with advantage more especially where thin walled cavities are present in both lungs and where selective collapse can be obtained. By "selective" is meant the full collapse of diseased portions of the lungs with relatively little interference with the healthy areas. In practice it is found that, in the absence of adhesions diseased areas collapse more readily than healthy lung so that selective collapse often occurs naturally under these conditions.

The commonest cause of failure in treatment by artificial pneumothorax, whether unilateral or bilateral, is the presence of adhesions over the area in which collapse is required. In such cases the help of a surgeon should be invoked for the direct examination of these adhesions through the thoracoscope so that he may proceed to divide them with a cautery if this be practicable (*vide* Plates 10 and 11). A contraselective pneumothorax should not be continued.

In cases where artificial pneumothorax is indicated attempts to introduce air into the pleural cavity may fail owing to generalised adhesion between the pleural surfaces. It may then be advisable to avulse the phrenic nerve on the affected side. This causes permanent paralysis of the corresponding half of the diaphragm with contraction of the lung in the vertical direction and a considerable diminution in its respiratory movements. In certain cases temporary paralysis of the diaphragm is preferred. This is obtained by crushing the phrenic nerve instead of its avulsion. Both these measures are useful adjuncts to treatment by artificial pneumothorax.

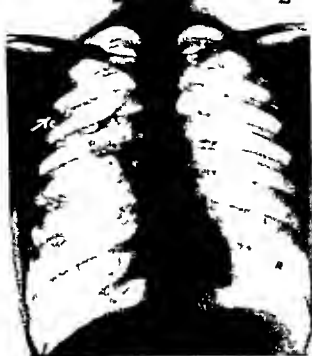


PLATE 10 — Right Artificial Pneumothorax with the Lung Edge (A) at 1 cm. Uncollapsed Cavity (B) to the Right Upper Lobe filled out by Adhesions (C)

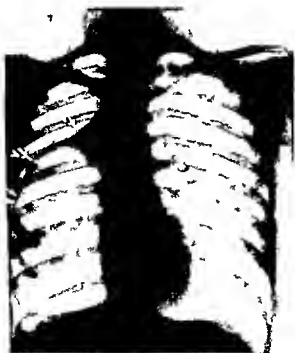


PLATE 11 — The same Case after the Adhesions have been divided. The lung edge is visible at A. The diseased area shows a complete selective collapse.

[To face page 120]

Cases in which the disease is relatively quiescent, for the most part unilateral, and in which extensive excavation and fibrosis are present often cannot be treated efficiently by artificial pneumothorax or phrenic nerve paralysis. In such cases it may be necessary selectively to collapse (by compression) the diseased area by thoracoplasty. The modern operation, which is extrapleural, involves the resection of some or all of the upper ten ribs, depending on the extent of the disease. It has been found advisable, if the lesion is extensive, to perform the resection in several stages. Regeneration of bony tissue occurs later leaving a rigid permanently collapsed chest wall. The operation is much more hazardous than the induction of a pneumothorax, but many excellent results have been achieved. In certain cases, particularly those showing fibroid apical lesions with cavitation, and a persistently positive sputum, effective collapse may be obtained by the operation of epicolysis, in which the apex of the lung is compressed by the insertion of a mass of paraffin wax between the outer layer of pleura and the chest wall. However, on account of the complication which the presence of paraffin wax produces, this operation is more and more being superseded by thoracoplasty or more recently by extrapleural pneumothorax.

SPECIFIC TREATMENT—After his discovery of the tubercle bacillus, Koch held out great hopes that tuberculin, a vaccine prepared from these organisms, would prove an effective remedy for the disease. This hope has faded and although many modifications of the vaccine have been tried, it has ceased to be generally employed in the treatment of pulmonary tuberculosis. Tuberculin appears to have slight value in the treatment of chronic cases with little toxæmia, and in certain types of extra pulmonary tuberculosis. Professor Calmette advocates the prophylactic immunisation of infants by the administration of living tubercle bacilli of diminished virulence. The preparation is known as BCG and is given by mouth during the first four months of life. It is being employed on a very large scale and the early results are encouraging.

CHEMOTHERAPY—No drug has a curative effect in tuberculosis comparable with that of the salvarsan group in syphilis. Definite benefit, however, is obtained in some cases from injections of sodium gold thiosulphate (Crisalbine Novaerysin Sanoerysin). Injections produce pyrexial reactions but in some instances are followed by abolition of an obstinate toxæmia, reduction in the quantity of sputum and a remarkable diminution of the moist sounds in the lungs. The drug is injected intravenously in aqueous solution starting with 0.05

gram Increasing amounts up to about 0.75 gram are given at weekly intervals so that a total of from 4 to 6 gram are given in a course lasting some six or twelve weeks In certain cases it may be advantageous to give the same total amount over a prolonged period by continued small weekly injections of 0.1 gram Other gold preparations, usually in oily suspension are sometimes administered intramuscularly

In every case the most careful supervision is essential, for severe reactions to the drug may occur These include exfoliative dermatitis, nephritis, stomatitis, gastro enteritis, anaemia, and agranulocytosis, and their premonitory symptoms or signs when observed contraindicate further injections The urine should be tested before each injection The drug, furthermore should not be used in incipient or acute types of pulmonary tuberculosis since in these it tends to cause extension and aggravation of the disease

HELIO THERAPY—Exposure of the naked body to direct sunlight or to ultra violet rays from artificial sources, though of proved value in the treatment of surgical tuberculosis, is not recommended in phthisis Its ill effects have long been recognised in the old maxim "the patient may see the sun, but the sun must not look on the patient"

Treatment of Symptoms—Cough—If coughing produces expectoration it must not be discouraged, but a dry, unproductive cough is harmful, and the patient must be taught to control it If sleep is interfered with, the cough may be reduced at night by an occasional teaspoonful of syrup of codein

Expectoration—Profuse expectoration is largely due to secondary infections These may be diminished by inhalations of turpentine and steam and by the regular emptying out of cavities in the lungs by postural exercises

Hæmoptysis—An initial hæmoptysis is seldom dangerous, but hæmorrhage in the later stages of the disease may be fatal, and in every case it is alarming to the patient It is essential that he should be reassured and kept quiet If the bleeding is profuse, the patient should be laid supine wherever he may happen to be and $\frac{1}{2}$ gr of morphia should be injected at once Larger doses of morphia are dangerous on account of its action in abolishing the cough reflex The patient is then given the contents of a capsule of amyl nitrite to inhale A blood transfusion given by the drip method is sometimes of value

Only rarely is it justified or indeed possible to check severe hæmoptysis by the induction of an artificial pneumothorax Needless to say, this should only be done when it is tolerably certain in which lung the bleeding is taking place

Slight haemoptysis or mere staining of the sputum calls for no special treatment. It may be evidence of increased activity and so indicate the need for rest in bed.

Treatment of Advanced Phthisis—In advanced cases treatment is designed to make life as tolerable as possible and, as cure is hardly to be hoped for, all restrictions are relaxed except such as prevent dissemination of infection to others. The patient is allowed up and about even though pyrexial. Many of his symptoms may be due to secondary infections in the lungs and resulting bronchitis. These render him intolerant of cold and exposure so that an indoor life becomes desirable. The usual treatment for bronchitis should be employed—anti-septic inhalations and a warm, moist atmosphere during the acute stage, while alkaline expectorants and vaccines will ameliorate a concurrent chronic bronchitis. On no account should such a patient be sent to a mountain resort for this will only add dyspnoea to his other troubles. Treatment of complications such as laryngeal and intestinal ulceration is dealt with in the sections devoted to these lesions.

TUBERCULOSIS OF THE PLEURA

The pleura is involved in all cases of pulmonary tuberculosis. Changes of varying extent are found at autopsy even if there have been no clinical manifestations of pleurisy. If pleurisy occurs in a patient with obvious signs of phthisis its true nature is easily recognised when however the lungs are apparently healthy a diagnosis of idiopathic pleurisy is often made. There can be no doubt that the majority of these are tuberculous. In the absence of heart disease and nephritis recurrent attacks of dry pleurisy or a single attack persisting for two or more weeks or pleurisy with effusion must be regarded as significant of incipient phthisis. In about 40 per cent of such cases active phthisis follows within six years. Moreover, a history of antecedent pleurisy is obtained from a very large number of phthisical patients.

The condition is more common in males than females and may occur at any age. It is least common in children and in them it is rarely followed by pulmonary tuberculosis. Sometimes the attack is provoked by exposure to cold or follows very heavy exertion.

Pathology and Morbid Anatomy—The pleural surfaces first the visceral and then the parietal lose their lustre and become dull and congested. A fibrinous exudate is formed

and in course of time thus becomes organised and replaced by fibrous tissue which binds the surfaces together. Similar adhesions are found between the lobes of lungs affected by tuberculosis. They are often dense and firm over the posterior aspect of the apex, and more slender and band like over the front of the upper lobe at the level of the third, fourth, and fifth ribs. Sometimes the entire pleural cavity is obliterated and the lung so firmly attached to the chest wall that it cannot be removed without tearing. A localised patch may be much thickened and calcified, forming a calcareous plaque.

In some cases a variable quantity of fluid exudate is poured out, and the condition becomes one of pleurisy with effusion. The exudate is usually serofibrinous, of a clear yellow or slightly greenish tinge, containing flocculi of coagulated fibrin, occasionally it is blood stained. Usually in tuberculous effusions the majority of the cells are small lymphocytes, but in the early stages a preponderance of polymorphonuclear cells may be found. Effusions which are absorbing frequently contain high proportions of eosinophils. Tubercle bacilli are seldom found by direct examination, even after centrifugalising the fluid, but culture or injection into a guinea pig will usually demonstrate their presence.

In rare instances the fluid is purulent, or becomes so after an interval. Tuberculous empyema is usually the result of the rupture of a peripheral cavity into the pleura. The fluid is turbid and more or less purulent. In many cases examination of the sediment shows it to consist of structureless debris. Tubercle bacilli are usually present while secondary infection is not uncommon.

DRY PLEURISY

Symptoms and Signs — Pleurisy accompanying active phthisis may cause no symptoms whatever, but as a rule there is a feeling of chilliness with sudden rise in the temperature and pulse rate, followed by more or less dyspnoea and pain. The severity of the pain varies with the situation of the pleurisy. If it is at the apex, there will be little more than a dull ache, but if it is over the more mobile portions of the lung such as the axillary or diaphragmatic surfaces, it may be agonising and it is always aggravated by cough or deep inspiration.

The characteristic physical sign is the friction sound or rub caused by the movement of the roughened surfaces over one another with respiration. The sound varies from a leathery creak to a fine crepitation, and the latter may be distinguished

from sounds arising in the lung only by the observation that friction accompanies expiration as well as inspiration. A rub may sometimes be palpable.

In diaphragmatic pleurisy no friction is heard. The central portions of the diaphragm are innervated by the phrenic and pleurisy of this part causes pain which is referred to the root of the neck and shoulder. The peripheral portions of the diaphragm are supplied by the lower six intercostal nerves, so that in this case pain is referred to the abdominal wall, and may simulate appendicitis, inflammation of the gall bladder, or other conditions calling for laparotomy.

Course.—After a few days the pain subsides, though it may recur in a mild form for years, especially during sudden changes of weather. The fever and cough abate after one or two weeks, but the friction sound may persist for months. Further attacks are common.

Treatment.—If the pain is severe the affected side must be strapped in such a way as to render it as nearly as possible immobile. Injections of morphia may also be necessary. In less distressing cases it will be sufficient to use counter irritants. The skin may be painted with tincture of iodine or a warm cataplasm such as antiphlogistine may be applied. Cough should be restrained by occasional doses of the syrup of codein.

PLEURISY WITH EFFUSION

Symptoms and Signs.—In some cases the formation of the effusion is insidious; in others it is preceded by the signs and symptoms of dry pleurisy. As the fluid collects the inflamed pleural surfaces become separated and the pain and the rub disappear. Pyrexia may be continued for many weeks with dyspnoea as the chief symptom.

The physical signs do not differ from those found in other varieties of pleural effusion. There is a striking impairment of mobility on the affected side, and "flat" dullness to percussion in the lower part of the chest. The upper limit of the dull area reaches its highest point in the axilla and thence slopes downwards towards the midline both in front and behind. The level is higher over the back than over the front of the chest. Over the dull area tactile fremitus and voice sounds may be completely abolished and the breath sounds absent or faintly tubular. The heart is displaced towards the unaffected side. If the underlying lung becomes atelectatic bronchial breathing and egophony may be audible posteriorly at or above the level of the hilum.

Confirmation of the presence of fluid is obtained by exploratory puncture. It is wise to infiltrate the skin, tissues of the chest wall, and the parietal pleura with 1 per cent novocaine. The fluid removed should be examined for organisms and its cell content.

The X ray appearance of a pleural effusion is characteristic. The fluid forms a dense shadow at the base, obliterating the outline of the diaphragm and obscuring the costophrenic angle. The upper border is indefinite, but can be seen to slope obliquely upwards and outwards. There is more or less displacement of the heart away from the side of the effusion.

Course and Treatment—If the effusion is small, the fluid may absorb in a few weeks, but a larger collection may persist for months. As a rule the pyrexia subsides before the fluid has disappeared. The presence of the fluid is probably beneficial and does good by immobilising a diseased lung. With large effusions however, the heart may be displaced to a dangerous extent and sudden death may result unless the excess of fluid be withdrawn. If there is distress or cyanosis, or if the heart is displaced more than 2 in., some of the fluid should be withdrawn in amounts determined by the relief experienced by the patient. Not more than a pint should be withdrawn at a time. Should radiological examination at this stage reveal an underlying tuberculous lesion it may be advisable partially to replace the fluid removed by air, and subsequently to continue the artificial pneumothorax. The routine air replacement of pleural effusions is not advised. In order to prevent undue fibrosis it is often wise to aspirate effusions which have persisted for more than six weeks.

Even if there is no sign of disease in the lung itself, the case must be regarded as one of incipient phthisis and a prolonged course of rest and preferably sanatorium treatment advised. The patient should not be allowed to resume work for at least six months.

Tuberculous Empyema—If the amount of fluid is insufficient to cause dyspnoea by its bulk, or if the virulence of the infection is insufficient to bring about severe toxæmic symptoms, the empyema is best left alone. In the presence, however, of either of these complications the fluid should be aspirated and replaced by air, and this procedure will of necessity have to be repeated at intervals, since the fluid tends to reaccumulate. The toxæmia may be diminished by instituting pleural washouts, at the time of aspiration with an antiseptic such as Dakin's solution. This should not be undertaken if a bronchopleural fistula is present. Since there is a tendency in these cases for sinuses to form along



PLATE 12 —Left sided pneumothorax. Note the absence of the normal pulmonary striations of the left side and complete atelectasis of the left lung.



PLATE 13 —Hydro-pneumothorax on Left Side with Cavity at Apex of the same Lung and Tuberculous Infiltration of the other Lung.

the tracks of insertion of the needles it is as well from the beginning to abstain from the use of local anæsthesia and to keep clear of the area of chest wall needed for thoracoplasty incision. Re expansion of the underlying lung may be promoted by closed drainage and suction. By far the greatest improvement will result (in those cases where the contralateral lung is free from active disease) from an extensive thoracoplasty on the affected side. The prognosis is however extremely grave whatever the treatment.

SPONTANEOUS PNEUMOTHORAX

In some instances the entry of air into the pleural cavity, in the absence of external trauma, is due to rupture of a tuberculous pulmonary focus into the pleura. By this means a fistulous opening is formed connecting the pleural cavity with one of the smaller bronchi. With each inspiratory movement air is drawn into the pleural cavity and the lung recedes from the chest wall. If the opening is a valvular one a considerable positive pressure will be attained and the heart and mediastinum will be displaced to such an extent that death may result in a few hours. As a rule the opening is not valvular and becomes sealed before the intrapleural pressure rises to a dangerous height (Plates 12 and 13).

The onset may be insidious and the condition may be discovered accidentally, but usually it is marked by a sudden stabbing pain in the side, dyspnoea, pyrexia and effusion of fluid into the pleural sac.

The majority of cases of spontaneous pneumothorax are due to causes other than tuberculosis. The commonest is probably the rupture of an emphysematous bulla, an accident which is apt to recur in the same patient often after an interval of years. In such cases the pneumothorax is often termed 'benign' and is seldom followed by pyrexia or the formation of fluid.

Physical Signs—The signs vary in proportion to the amount of air which gains entrance to the pleural cavity. A small collection limited by pre-existing pleural adhesions may defy detection except by stereoscopic skiagraphy. Larger amounts, even if sufficient to cause generalised collapse of the lung, may be overlooked by good clinicians, for when the intrapleural pressure remains negative, there may be no abnormal signs whatever, except absence of the breath sounds in the lower part of the affected hemi thorax. When the pleural cavity is inflated sufficiently to convert the normally negative pressure into a positive one we find all the classic signs which make

diagnosis easy On inspection there is slight impairment of movement and the cardiac impulse is displaced towards the unaffected side On percussion the note is hyper resonant on auscultation the breath sounds are absent or distant and amphoric in type In some cases musical tinkling rales are heard if a bronchopleural fistula is present If an assistant press a coin flat on the chest wall and strike it with a second coin the examiner listening with his stethoscope over another part of the pneumothorax may hear a clear ringing note the bell sound or coin sound Voice conduction is usually not materially altered

A skiagram shows undue transparency and a complete absence of the normal pulmonary striation in the pneumothorax cavity The collapsed lung is seen lying against the hilum (vide Plate 12)

Treatment—The patient is confined to bed and if he is suffering from shock should be given morphia and kept warm If the pleural cavity is overdistended and the patient distressed air must be withdrawn If X ray examination shows the collapsed lung to be grossly diseased and the other one to be reasonably healthy the pneumothorax is likely to be beneficial and it should be maintained by periodical injection of further quantities of air In the absence of clinical or X ray evidence of pulmonary disease the pneumothorax is probably non tuberculous and may be allowed to absorb

HYDRO PNEUMOTHORAX—In many cases of artificial and spontaneous pneumothorax serofibrinous fluid collects in the pleural cavity after some time The presence of the fluid is often detected by the patient who notices a splashing sensation inside the chest when he moves On examination this splash may be heard by shaking the patient during auscultation with the stethoscope Percussion reveals dullness above the diaphragm and the upper limit of the dull area encircles the affected side of the chest horizontally On tilting the patient to one side the fluid moves and again takes a horizontal level thus differing from uncomplicated pleural effusions which seldom move at all in response to gravity The skiagraphic appearance is characteristic the fluid shows as a dense opacity at the bottom of the chest and above it sharply defined horizontal surface the clear translucent pneumothorax cavity is seen with the lung collapsed about its root (vide Plate 13)

Treatment—The presence of fluid though suggestive of a tuberculous cause does not alter the treatment of a case of spontaneous pneumothorax

Pyo Pneumothorax—In some cases infected purulent fluid collects in the pleura after spontaneous pneumothorax. The patient is feverish and toxic. Investigation will usually show the lesion to be tuberculous. Therapy is that of tuberculous empyema unless a simple pyogenic cause is proved in which case drainage is needed.

LARYNGEAL TUBERCULOSIS

Ætiology—This is a common complication of pulmonary tuberculosis occurring in from 10 to 15 per cent of sanatorium patients. Primary tuberculosis of the larynx is exceedingly rare and pulmonary tuberculosis almost invariably precedes laryngeal disease. Misconceptions arise because the laryngeal lesion may arrest attention before signs of pulmonary disease become obvious. Radiological examination of the lungs is essential in every suspected case. Laryngeal tuberculosis occurs in men more than twice as frequently as in women.

Morbid Appearances—Tubercles form in the mucous membrane, giving rise to edema and later to ulceration. Sometimes the epiglottis is chiefly affected, producing considerable swelling of this structure together with the mucous membrane covering the arytenoids and the ary epiglottidean folds. The disease may attack chiefly the vocal cords causing thickening and ulceration of one or both cords commonly in the posterior half. In nearly every case there is swelling of the mucous membrane on the arytenoids and thickening of the posterior commissure which runs between them.

Symptoms—When the disease attacks the epiglottis and entrance of the larynx pain is the predominant symptom. It may be dreadfully severe and, being provoked by the act of swallowing may lead to rapid emaciation as the unfortunate patient will not take food. Where the lesions are limited to the vocal cords and arytenoids pain may be absent and the only symptoms will be hoarseness or complete aphonia.

Prognosis—The outlook in phthisis is rendered more gloomy by the occurrence of tuberculous laryngitis but it is by no means hopeless.

Treatment—Every effort must be made to deal adequately with the disease in the lungs as this is the controlling factor. For the laryngitis, the first step is to enforce complete silence the patient making all communications by writing or by signs and it may be necessary to persist with this measure for many months. Local treatment includes cauterisation in selected

cases where granulations are abundant. Apart from these measures therapy is largely symptomatic. Inhalations of oil of cinnamon and creosote on a Burney Yeo inhaler may alleviate the cough while severe dysphagia should be treated by spraying the larynx just before each meal with a 5 per cent solution of cocaine or by insufflation of benzocaine (anæsthesm) through a Leduc's tube. In intractable advanced cases alcohol injection of the superior laryngeal nerves may be necessary.

LYMPHOGENOUS DISSEMINATED TUBERCULOSIS

(*Glandular Tuberculosis*)

The structure of the lymphatic system with its intercalated lymph glands and numerous interglandular lymph vessels, the low pressure obtaining within these vessels and the temporary fluctuations in the direction of flow of lymph make possible a relatively slow dissemination of tuberculosis widely throughout the body.

Primary tuberculous infection with consecutive involvement of the regional lymph gland commonly in turn leads to more or less extensive infection of neighbouring lymphatics and the glands into which they drain. Temporary or permanent arrest of the process may take place at this point and the tissue reactions associated with healing occur. Sometimes however dissemination continues until virtually generalised lymphatic glandular tuberculosis results. Not infrequently reactivation of glandular disease after a variable period of arrest is followed by further extension. Since the general direction of lymph flow is centripetally toward the thorax the spread of the disease from peripheral primary foci in for example the intestines or tonsil tends to be in that direction. Secondary hæmatogenous lesions in viscera and the adult type of pulmonary tuberculosis seem rarely if ever of themselves to give rise to lymphatic glandular tuberculosis though direct hæmatogenous spread to lymph glands undoubtedly occurs. On the other hand hæmatogenous spread from an infected gland is a persistent possibility. Apart from this risk the disease is relatively benign and it is possible that considerable immunity to tuberculosis later in life may thereby be developed. In England children between the ages of four and twelve are predominantly affected though the disease is by no means rare in adolescence and young adult life. A high proportion of cases when mesenteric or cervical glands are outstandingly involved are due to bovine tubercle

breith The relative preponderance of cases in which cervical glands seem exclusively concerned is more apparent than real and is due to their superficial situation for in fact the mediastinal glands are by far the most commonly infected group

The appearance of the child with active glandular tuberculosis often suggests the "tuberculous diathesis" with a clear beautiful complexion marled hirsuties, and long eyelashes. Sometimes in children, and commonly in young adults, extensive glandular tuberculosis is associated with cutaneous striae and occasionally petechia.

Recurrent pyrexia, sweating, loss of weight or failure to gain weight, malaise, and lassitude may occur independently of the site of the glands involved. The clinical features otherwise depend on the localisation of the adenitis. Thus in the neck superficial enlargement may be visible and palpable. Such glands are commonly matted together and to surrounding structures including the skin. The latter may be eroded and a discharging sinus form which takes a long time to heal and may cure extensive scarring. Pain and tenderness are usually inconspicuous until secondary infection takes place. When caseous, the glands are hard to palpation, with liquefaction which may itself be associated with secondary infection from tonsils or teeth the mass may feel cystic.

Mesenteric tuberculous adenitis is commonly symptomless, but if extensive may give rise to progressive debility, asthenia, stunting of growth, pain, anaemia and persistent diarrhoea with fatty or watery stools. The abdomen may be distended, and associated tuberculous peritonitis is not uncommon. The mass of glands may be palpable, while with healing intestinal obstruction may occur.

Local symptoms associated with mediastinal lymphadenitis are cough, and occasionally pressure symptoms on mediastinal structures such as veins or bronchi. Bronchial obstruction from this source causes pulmonary atelectasis and leads ultimately to bronchiectasis in a considerable number of cases. Liquefaction within these glands leads to the formation of a mediastinal abscess in rare instances.

The physical signs of enlarged mediastinal glands described by d'Espine and Jastaco Smith are inconstant, and diagnosis is largely dependent upon symptomatology and X-ray examination.

Tuberculous lymphadenitis must be distinguished from Hodgkin's disease, the leukaemias, lymphosarcoma, neoplastic disease, sarcoidosis, and syphilis. Less commonly chronic pyogenic adenitis, glandular fever, coeliac disease, and sprue

may resemble the condition. The age, history and appearance of the patient, the local characteristics of the glands if these are accessible or their radiological appearances if within the thorax, the state of the blood and spleen, the presence of foci of infection, the Mantoux reaction, and if possible histological examination of an excised gland, will usually permit diagnosis.

Treatment for the most part consists of rest, good surroundings with fresh air and good food. Graduated exposure to sunlight or ultra violet light cod or halibut liver oil and if necessary extra vitamins B and C, and iron or liver extract depending on the type of anæmia present are often of value. Cervical glands are sometimes best treated by X ray therapy, especially at an early stage while their surgical removal is also often successful and may prevent the formation of an unsightly sinus.

W D W BROOKS

TUBERCULOSIS OF THE ALIMENTARY TRACT

Tongue—Tuberculous ulceration occasionally occurs, the ulcer is single, median, and near the tip of the tongue. There is usually little induration and no enlargement of lymphatic glands, but the lesion may be exceedingly painful and produce dysphagia. The condition is usually secondary to pulmonary tuberculosis.

Pharynx—During the terminal stages of phthisis, tuberculous ulceration of the larynx and epiglottis may extend to the pharyngeal wall and mouth.

Intestines—Tuberculous ulceration of the ileum and colon is very common in advanced pulmonary tuberculosis, due to the swallowing of tubercle bacilli. It is found at autopsy in about 50 per cent of patients dying of phthisis. Much less frequently it may occur as an apparently primary condition and is then often associated with tuberculosis of mesenteric glands.

Pathology—Tuberculous ulcers of the ileum originate in the Peyer's patches and the solitary follicles. Spreading round the lymphatic vessels they become transverse and may encircle the intestine. The edges of the ulcers are irregular and the overlying peritoneum is studded with miliary tubercles. Perforation very rarely occurs owing to the tendency for adhesions to form. The latter may produce intestinal obstruction, or cicatricial contraction of healing ulcers may narrow the lumen of the intestine. The ulcers are multiple and most numerous towards the lower end of the ileum. *Fistula in ano* is tuber-

culnus in a small proportion of cases and its occurrence always renders a careful examination of the chest advisable.

Symptoms—Until the ulceration becomes widespread there may be little direct indication of intestinal involvement. Later there is a troublesome diarrhoea with loose watery stools without the presence of blood or mucus. As a rule abdominal pain and tenderness are not prominent.

Diagnosis—The discovery of tubercle bacilli in the faeces does not necessarily indicate ulceration of the intestine. Ulcerated areas of the colon are hyper-irritable and an X-ray examination may show persistent rapid emptying of the affected part of the gut.

Treatment—When the condition is advanced the outlook is hopeless, and only palliative measures are possible. In earlier stages the treatment is on similar lines to that of tuberculosis in other organs.

Hypertrophic Tuberculosis of the Caecum—This type of intestinal tuberculosis is extremely rare and unlike ordinary tuberculous ulceration of the intestine tends to occur unassociated with tuberculosis elsewhere. The disease involves the caecum, the ileocaecal sphincter and the terminal coil of the ileum and there is often enlargement and caseation of the neighbouring glands. The lumen of the bowel becomes much narrowed by infiltration of its wall and obstructive symptoms may occur. A mass is palpable in the right iliac fossa which may be mistaken for a growth. Exploration is nearly always necessary to elucidate the diagnosis and excision is often very successful. Most of the cases diagnosed as hypertrophic tuberculosis are probably really Crohn's disease (*vide p. 432*).

TUBERCULOUS PERITONITIS

Aetiology—Tuberculous peritonitis is chiefly seen in children and in young adults though it may occur at any age. Patients with cirrhosis of the liver sometimes develop tuberculous peritonitis. The route of infection is often doubtful but usually tuberculous lesions can be found elsewhere in the body. Infection probably reaches the peritoneum by way of the lymphatics or the blood stream. The haematogenous origin accounts for the generalised miliary type and the lymphogenous for the localising form of tuberculous peritonitis.

Symptoms—There are three main clinical types of the chronic disease: (1) the ascitic, (2) the caseous or loculated

and (3) the fibroid, these types depend in part on the method of infection and in part on the resistance of the patient

The *ascitic type* is common in children and adolescent girls. The exudate develops gradually, and though the abdomen may be greatly distended with fluid, the symptoms are often slight. The patient loses weight and strength and has a mild evening fever. Susceptible animals inoculated with the ascitic fluid develop tuberculosis.

In the *loculated type* the fluid is encysted, and these collections of exudate and the masses of tubercles with surrounding fibrosis may produce palpable tumours of various sizes and shapes. The intestines become matted together. The omentum is infiltrated with tubercles, and may often be felt lying transversely in the upper abdomen. Due to the interference with peristalsis there are many gastrointestinal symptoms. Colicky pain, bouts of nausea and vomiting, and alternate obstinate constipation and diarrhoea are common. Pale, bulky stools containing unabsorbed fat are often a feature resulting from occlusion of lacteals. An evening rise of temperature, tachycardia and wasting occur. The caseous nodules are apt to break down and become secondarily infected. Fistulae between various portions of the intestine or through the abdominal wall especially at the umbilicus, may ultimately develop.

The *obliterative or chronic fibroid type* is a healing process in which there is widespread formation of connective tissue and no exudate is present. The intestinal tract is bound down by dense adhesions, and obstructive symptoms and signs often result. Abdominal pain may be severe in this type, and is increased on movement. The patients show much emaciation and weakness but usually there is no fever.

Diagnosis—The ascitic type is unlikely to be confused with cirrhosis or malignant peritonitis as it is rarely seen except in children or adolescents. A large ovarian cyst may give rise to difficulty, especially with encysted effusions in the lower abdomen. A positive Mantoux test is of value in children under 5 years of age and enteric fever can be excluded by agglutination tests. The ascitic fluid in tuberculous peritonitis has a specific gravity of 1.015 or over, and contains lymphocytes and often red cells. If inoculated into a guinea pig tuberculosis will develop. A straight X ray of the abdomen taken erect may show multiple fluid levels owing to partial obstruction of loops of small intestine.

Prognosis—On the whole the chronic ascitic type does best especially in children or young adults. The loculated caseous

type has the least favourable outlook. Cases are encountered which run an extremely chronic course with pyrexia and continued ill health over many years.

Treatment—The usual treatment for tuberculosis should be carried out—months of rest, fresh air, an abundant mixed diet and sunshine. Heliotherapy is often most valuable provided there is no active lesion elsewhere. Surgery is sometimes necessary in dealing with complications such as intestinal obstruction. Repeated paracentesis may be required if large amounts of fluid are present.

The constipation may be relieved by liquid paraffin or mild laxatives. Diarrhoea, if severe, can often be controlled by opium or large doses of bismuth. Fatty stools necessitate reduction of fat in the diet but fat soluble vitamins should be added.

TREVOR OWEN

RENAL TUBERCULOSIS

Very commonly in miliary tuberculosis and in chronic phthisis the kidneys are found to be the site of miliary tubercles or tuberculous nodules. These, however, have no clinical significance. True renal tuberculosis arises in three ways: (a) through the blood stream, (b) ascending infection from tuberculous lesions in the urinary and genital organs via the perireticular lymphatics and rarely, (c) from direct extension from neighbouring organs. Renal tuberculosis is probably always secondary to a primary lesion elsewhere in the body, and infection via the blood stream is the most common mode of spread to the kidneys. Males are more frequently affected than females in the proportion of 3 to 1, and most cases occur between the ages of twenty and thirty years though it may be met with at all ages. Both kidneys may ultimately become involved, though usually one is affected before the other.

Pathology—The lesions in the kidneys resemble tuberculous lesions in other parts of the body and consist of tubercles which coalesce and then caseate. In the earliest stage the disease is seen to begin at the base of the pyramids spreading thence to involve the calyces. The upper pole of the kidney is usually first affected but the process may also begin in the lower pole. Caseation and ulceration may lead to abscess formation, the contents of which may be discharged into the pelvis and the whole kidney may thus become converted into a collection of infected cysts. The ureters are generally thickened and

ulcerated, and the bladder, *vesiculæ seminales* and testes are often infected

Symptoms—The cardinal symptoms of renal tuberculosis are (1) frequency, (2) pain, and (3) pyuria. Frequency is generally the earliest and most constant symptom and its importance as an aid to diagnosis cannot be over-emphasised. It may occur even before the bladder becomes involved and may be mistaken for cystitis. Pain in the form of a constant dull ache in the loin is also an important and early symptom. It is worse at night and is not relieved by rest or posture. Severe pain resembling that of renal colic occurs at times with the passage of clots of inspissated pus and debris down the ureter. Hæmaturia is not a conspicuous symptom in most cases but it may be the first sign of the disease, and in a mild grade is present at some stage in the course of most cases. In males a symptomless thin milky discharge from the urethra, giving rise at first to suspicion of gonorrhœa, may be the first sign of renal tuberculosis. It arises from irritation or infection of the prostate, and may be quite sterile or contain tubercle bacilli. Later the usual constitutional symptoms of tuberculosis develop. Pyrexia, wasting, anorexia, anemia, and night sweats all occur. In many cases secondary invasion of the bladder leads to symptoms of cystitis which overshadow those due to the renal disease. Tenderness and a palpable mass in the loin usually denote a pyonephrosis. In the early stages the urine is abundant, of low specific gravity, and acid in reaction. The amount of pus present varies from a few cells to large quantities, which settle at the bottom of the specimen glass as a white layer. Tubercle bacilli are frequently present but often careful and repeated searches are necessary for their detection, which is best effected in a twenty four hours specimen. It is usually wise to confirm the diagnosis by growth on special media or inoculation of guinea pigs. Tuberculous bacilluria without renal tuberculosis has been reported. Renal tuberculosis rarely heals, and treatment consists essentially in the removal of the kidney and ureter before the opposite side becomes involved. Early diagnosis therefore, is of the utmost importance.

Diagnosis—The diagnosis has to be made from other conditions which cause frequency, pain, pyuria and hæmaturia such as nephrolithiasis, cystitis, pyelitis, pyonephrosis, vertebral disease, enuresis, nephritis, essential hæmaturia, and malignant disease. The discovery of a tuberculous lesion elsewhere (either in the lungs or the lower genito-urinary tract) is of significance. Cystoscopic examination should never be omitted as the finding of the characteristic puckering and retraction of the ureteric

orifice on the affected side is diagnostic. Since a positive diagnosis usually leads to removal of the affected kidney and uriter, it is important that the renal function of the unaffected kidney be carefully estimated.

Treatment.—When one kidney has been removed for tuberculous disease, much may be done to prevent the remaining organ from becoming involved. Plenty of fresh air, good food, and adequate rest are essential. The mode of life should be that prescribed for quiescent cases of pulmonary tuberculosis. In inoperable cases with much pain and incessant frequency it is not generally recognised that strict and absolute rest in bed of the type enforced in active pulmonary tuberculosis will often give prolonged relief from intolerable distress. Tuberculin is often prescribed in renal tuberculosis, but its value has not been proved.

A. A. OSMAN

TUBERCULOUS DISEASES OF THE SKIN

This large and important group is naturally divided into two parts: the first is concerned with diseases caused by the multiplication of tubercle bacilli in the skin, the second with a series of exanthemative eruptions which are an expression of active tuberculous disease elsewhere.

The first group—progressive tuberculosis of the skin, includes five conditions: (1) The primary complex, (2) tuberculous ulceration of the skin, (3) tuberculosis colliquativa, (4) verrucous tuberculosis, (5) lupus vulgaris.

PROGRESSIVE TUBERCULOSIS OF THE SKIN

The Primary Complex in the Skin.—This is seen only in those who have not been previously infected with tuberculosis, naturally it occurs most often in children, though not always.

The initial lesion is a papule or small nodule which quickly becomes dimpled or ulcerated owing to necrosis in its centre, it bears quite a close resemblance to a syphilitic chancre and it is always accompanied by regional adenitis, sometimes the regional gland becomes grossly enlarged within a few weeks, and it often eventually breaks down. This phase is sometimes accompanied by erythema nodosum.

In the course of months the primary sore either disappears

spontaneously or it becomes a small patch of lupus vulgaris. There is not, however, the tendency to peripheral extension that is usual in lupus, and spontaneous resolution, both of the sore and of the adenitis, is not uncommon.

Tuberculous Ulceration (*Tuberculosis Cutis Orificialis*)—This condition is met with only in those with rapidly advancing internal tuberculosis, especially phthisis, and as an extension of this process. It is most often situated on the lips and sometimes about the anus and genital organs. It begins in the form of milium tubercles which rapidly undergo caseation and ulceration. The ulcer is soft and is usually covered with a crust which when removed reveals a reddish yellow floor exuding thin sero-purulent matter. As a rule there is little pain. There is gradual extension with little tendency to healing.

Tuberculosis Colliquitiva (*Scrofuloderma, tuberculous gumma*)—These rather uncommon lesions begin as sluggish hypodermic nodes which become adherent to the skin within a few days and develop a deep red or reddish purple tint, softening commences in the superficial part of the lesion, which generally breaks down within two or three weeks and evacuates serous or sero-purulent matter, often intermingled with blood. This may continue to discharge for weeks or months, either through one or several fistulous openings, or an open ulcer may be formed with an irregular undermined margin. Spontaneous cure is, however, usual, and it is not uncommon to find the scars of old lesions, often adherent to underlying tissues. Tuberculous gummata occasionally arise as a direct extension from underlying bone joint or glandular disease, or they may, on the other hand, give rise to disease of underlying tissues such as tendon sheaths. They are often found over prominences, such as wrists, metacarpo-phalangeal joints, malleoli, the forehead, scalp, and the neck, but they may occur anywhere. They are seen chiefly in infants, young children, and in adolescents. They are always an expression of tuberculosis elsewhere, sometimes visceral, sometimes of the bones, joints, or superficial glands.

Diagnosis—The lesions are often mistaken for furuncular abscesses and sometimes for tertiary syphilis, but their indolent course, bluish tint, characteristic type of ulceration, or fistulous openings and tracts, together with the fact that underlying bone or joint tissue may be affected in connection with one or more of them, serves to simplify the diagnosis. Tubercle bacilli can often be found by culture or direct examination of material withdrawn from an unbroken abscess. On the face

in infants they are sometimes on account of their bluish colour, mistaken for cancerous ulcers.

Tuberculosis Verrucosis Cutis (*Verruca Necrogenica*) — Generally situated on the hand, fingers, or thumb with a predilection for the radial margin occasionally about the anus the lesion is an infiltrated plaque surmounted by warty excrescences and surrounded by a red or violaceous zone. Droplets of pus can sometimes be expressed. At first a papule, it very slowly extends peripherally to form a disc shaped plaque. In this stage it presents three zones — a peripheral red or violaceous areola, an intermediate infiltrated zone surmounted by warty projections and a central warty area which has undergone partial cicatrization.

The cause is direct inoculation of the tubercle bacillus into the skin a fact which explains the predilection of the disease for the hands. It may occur, however, on other parts, such as the wrist, elbows, feet, knees and face, and in phthisical subjects the perianal region. The name *verruca necrogenica* was given to the disease because it formerly occurred with some frequency among post mortem workers.

Lupus Vulgaris — The primary lesion of lupus is an intra dermal nodule from the size of a pin's head to that of a small pea, flat or slightly raised above the surface. It is reddish yellow in colour, and on vitro pressure appears as a brownish yellow opalescent spot. The surface may be smooth, covered with scales or crust, or it may be ulcerated. Though firm to touch its consistency is in reality rather soft. A patch of lupus enlarges by the appearance of other lupus nodules in the immediate neighbourhood of the initial lesion. The natural tendency is towards very gradual peripheral extension accompanied by more or less cicatrization of the older part of the lesion and sometimes by ulceration. The sclerosis destroys by strangulation some of the older lupus nodules but fresh nodules often appear in the scar tissue, a point which serves to distinguish lupus from serpiginous tertiary syphilis of the skin, in which fresh lesions are rarely found in scar tissue.

The sites of election of lupus are the face, particularly about the nose and cheeks, and the neck, but the disease is often found on the trunk and limbs very rarely on the palms soles, or the sculp. A single patch is rather more common than multiple patches. There are many clinical varieties of lupus which have received descriptive names.

Disseminate Lupus — The lesions are multiple and scattered over different parts of the body.

Agminate Lupus — The common type, in which the disease

forms a plaque spreading centrifugally by the formation of fresh nodules and cicatrising in the centre

Erythematoid Lupus—A very superficial variety. The lupus nodules are very small and sometimes difficult to see. They are situated on a reddened, superficially cicatrised skin and sometimes occupy the nose and cheek. In this situation they are often mistaken for lupus erythematosus.

Elephantiasic Lupus—This variety occurs especially on the limbs, but may also occur on the face where it gives rise especially to elephantiasis thickening of the upper lip. The affected region is swollen as the result of invasion of the lymphatics.

Lupus Eredens—This term is applied to a rapidly advancing form of lupus always accompanied by ulceration and sometimes by severe mutilation of the affected parts.

Lupus tumidus, *lupus hypertrophicus*, *squamous lupus* are terms that explain themselves. More than one of these clinical types may commonly be found on the same patient or in different parts of a single patch of lupus.

Ætiology—Lupus can begin at any age, but is principally a disease of childhood becoming less common towards adolescence and rather rare after thirty. It is very rare in phthisical subjects though phthisis may develop as a terminal event. Tuberculous adenitis is however rather common. Lupus may be a direct infection of the skin but it more often originates by spread along the lymphatics from infected mucous membranes or lymphatic glands. The disseminated type often follows measles it is no doubt in this case a blood borne infection. The nasal or buccal mucous membrane is often primarily infected, which explains the frequent occurrence of the condition on the face or nose. Lupus of the nasal fossæ may give rise to epiphora by blockage of the lachrymal duct. The eyelids are also sometimes attacked by lupus as an extension of the disease from this source. Lupus of the mucosa of the mouth palate or gums occurs in the form of large or small bud like granulations producing by confluence a mamillated or by cicatrization a reticular appearance or it may ulcerate in parts.

Evolution and Complications—Untreated lupus always lasts indefinitely. Its mode of progression is by way of the lymphatic channels in the corium. During its course certain complications are common and of these the most important are elephantiasis of a limb or of the lips, pulmonary tuberculosis, erysipelas and epithelioma. This last serious complication is sometimes the result of the treatment of lupus by X ray, but

it has frequently occurred on scarred lupus which has not been so treated

Treatment—Lupus is an extremely difficult disease to cure, its treatment has however made important strides in recent years. Though hope of effecting a complete cure in very severe and extensive cases must be abandoned, excellent results may be obtained in all cases limited to a few small patches and in many of moderate extent. Treatment must be both general and local. Following the brilliant results of heliotherapy obtained by Rollier in Switzerland institutions for similar treatment have been established in other countries. Treatment by graduated sun baths has proved the most effective method of combating the disease. In England and in the northern continental countries where natural sunlight is only available in summer, heliotherapy has been supplemented by graduated exposures to artificial sources of ultra violet light. This is of very great value but is however considerably less effective than natural sunlight. The latter, aided by the added stimulus of the open air, gives rise to a considerable increase in metabolism an effect which is absent in lamp treatment of any kind. Of the various types of lamp, the carbon arc has proved itself the most useful.

Local Treatment—When complete surgical excision is not advisable much may be effected by local treatment with concentrated ultra violet light or diathermy. Good results can only be obtained with phototherapy by experts working with satisfactory equipment such as Linsen or Linsen Lomholt lamps. Details must be sought in textbooks on dermatology.

Selective caustics such as liquid acid nitrate of mercury for the skin and zinc chloride for mucous membranes, may be applied locally in addition to general heliotherapy.

The injection of the ethyl ester of hydrocarpic acid (Eulykol) directly into the lupus nodules is a valuable remedy in some of the cases in which the disease is limited to one or more small foci. It appears to be effective when it is followed by considerable local swelling the appearance of the lesion suggesting a marked increase of the tuberculous process. The swelling is however absorbed in the course of several weeks, and with it sometimes the tuberculous tissue. The cosmetic result is excellent.

Prognosis—Well treated lupus has a satisfactory prognosis if diagnosed early. The very extensive and mutilating cases, and particularly those accompanied by elephantiasis, are however incurable, all patients must be kept under observation for years even after apparent cure.

EXANTHEMATIC TUBERCULOUS ERUPTIONS

These consist of—

- 1 Miliary tuberculosis of the skin
- 2 The tubercules
- 3 Sarcoid of Boeck (lipoid of Boeck miliary lipoid
Lymphogranuloma benigna of Schaumann Lupus
pernio)

The greater number of these eruptions belong to a group named by Darier *Tuberculides*. They are a series of cutaneous and subcutaneous eruptions related to central tuberculosis. They differ from the progressive forms of tuberculosis of the skin in having a wider and usually symmetrical distribution and the individual lesion has a definite tendency to spontaneous cure. They may exist in combination with easily recognisable tuberculous disease elsewhere or the eruption may be the only obvious evidence of infection. It is probable that emboli derived from a central focus become lodged in the skin and stimulate a reaction papule nodule or subcutaneous nodule which results in the destruction of the bacillus. In general the tubercules occur in those whose resistance to the infection is high and the prognosis is usually though not invariably good.

They may be classified as follows —

- 1 Lichen scrofulosorum
- 2 Papulonecrotic tubercule including acne scrofulosorum
- 3 Miliary lupus (acne agminata acutis)
- 4 Bazin's erythema induratum

Erythema Induratum —Of the tuberculides Bazin's disease is met with considerably more often than any of the other types. It is seen almost exclusively in adolescent and young adult females with sluggish peripheral circulation. The lesions are found mainly on the posterior and outer aspects of the lower two thirds of the legs. They begin as firm subcutaneous nodes which in the course of a few weeks involve the skin and become red or blue in colour. Some of them soften and open on the surface discharging thin sanious material or forming an ulcer which heals slowly others are absorbed. Individual lesions tend to gradual spontaneous cure but they are succeeded by others. Cold weather aggravates the condition but it does not disappear altogether in summer. It is sometimes accompanied

by the pyodermotic tubercule elsewhere, notably the fingers, hands, and elbows.

A nutritious diet, rich in vitamins, combined with carbon arc lamp or helio therapy is the treatment of choice. Treatment by neosarsphenamine has also proved to be valuable in a number of cases. The legs should be kept as warm as possible by thick stockings and high boots lined with wool. Exceptionally a period of rest in bed is necessary.

For descriptions of other types of tubercule, milium tubercules of the skin, and sarcoid of Bock, the reader is referred to works on dermatology.

G. B. DOWLING

VENEREAL DISEASES

GONORRHOEA

GONORRHOEA is an inflammatory disease of the mucous membrane of the genito urinary passages, due to infection by the gonococcus, which may extend locally to the genital glands and may cause systemic complications

It is a widespread condition affecting both sexes. Although almost invariably contracted during coitus, infection from closets, articles of toilet, clothing and towels is possible and is not uncommon in female infants. The incubation period varies from three to ten days.

The gonococcus is a minute, gram negative, kidney shaped diplococcus, which is cultivated with difficulty. In recent infections the gonococci are plentiful and are found in clusters within the pus cells and in scattered pairs between the cells. Outside the tissues it dies rapidly when dried, but if moist and warm it may live for several days.

The parts affected in the male are primarily the urethra, from which the infection frequently spreads to the epididymis, prostate gland and seminal vesicles.

In the female the initial infection involves the urethra and cervix, later the uterus and Fallopian tubes may be affected. The vulva, lower vagina, urethra, and rectum are liable to be infected in female infants.

GONORRHOEA IN THE MALE—The initial symptom is a slight irritation or scalding during micturition, soon followed by a purulent discharge. The lips of the urinary meatus are tender, swollen and everted. The urethral mucous membrane is œdematous, injected, and bathed in pus, the glands of Littre and the lacunæ are infected, periurethral swellings and abscesses may result which sometimes rupture externally on the under surface of the penis or in the perinæum. Inguenal adenitis is common though suppuration is rare.

After several weeks the acute inflammation subsides, but a condition of intermittent urethral discharge, known as *gleet*,

becomes established and the urine contains yellow opaque threads which contain gonococci. This stage may last from a few weeks to many months being usually dependent on a chronic infection of the glands of Littre or of the lacunae—lesions which can be identified by means of a urethroscope. This chronic infection frequently results in subepithelial infiltration which if marked forms a soft or inflammatory stricture. Years later a hard fibrous stricture may follow.

The infection often spreads to the posterior urethra in the second to the fourth week. The onset is frequently insidious but may be acute and cause frequency of micturition with pain slight fever general malaise and haematuria. When there is acute infection of the prostate gland a large hot tender swelling in which the seminal vesicles may participate can be felt per rectum. Constant perineal pain and dysuria are usual but pain on defecation is slight. Retention of urine is a common accompaniment. True abscess formation is rare. This usually ruptures into the urethra or occasionally into the rectum with immediate relief. Subsequent gonococcal proctitis is rare. When rupture is delayed malaise toxæmia and fever are marked, rigors are not infrequent and the condition may simulate malaria or endocarditis.

Chronic prostatitis and vesiculitis produce a persistent urethral discharge. More often repeated relapses occur over many years and may cause arthritis and iritis. On rectal examination enlargement and nodules may be recognised. The condition is frequently intractable partly on account of the inadequate drainage but chiefly because of the absence of characteristic localising signs or symptoms. In many instances the diagnosis can be made only by the detection of pus and bacteria in the prostatic secretion or semen. A urethral discharge experienced only on defecation is suggestive of such infection. Secondary invasion with pyogenic or coliform bacteria is a constant feature. Gonococci are rarely found after the first few months.

Gonococcal infection of the epididymis is a frequent complication, an acute tender swelling appears in the scrotum formed chiefly by the lower pole of the epididymis. Suppuration however, rarely occurs. Hard nodules may persist in the epididymis for months, and sterility is frequent after bilateral infection.

Treatment—General measures consist of rest in bed and the avoidance of alcoholic drinks and condiments. Alkaline mixtures should be prescribed and plenty of bland fluids taken.

Sulphapyridine effects a speedy cure in about 80 per cent

of recent uncomplicated infections. In ambulant patients 1 grm. is given, t.i.d., at intervals of six to eight hours for seven days. The drug should be given as soon as gonococci have been identified and should not be employed until there is bacteriological confirmation. The discharge frequently disappears within two days, but the premature cessation of chemotherapy at this stage will almost invariably be followed by a relapse. Underdosage in the first few days of treatment is a common cause of failure and many undertreated cases prove refractory to further increased dosage.

Local treatment is useful, particularly in sulphonamide-resistant cases and in chronic infections; irrigation of the anterior urethra for the first ten days and then of the whole urethra and bladder should be carried out twice daily by the gravity method with potassium permanganate 1 in 8,000, or flavine 1 in 8,000. Acute prostatitis or vesiculitis requires rest in bed with rectal douches of hot saline; pain and frequency of micturition may be relieved by *Tr. Hyoscyamus Mxx* orally, or if severe will require rectal suppositories of morphia and atropine; kaolin poultices or *lotio plumbi c opio* will relieve the pain in acute epididymitis.

Chronic urethritis in the male may persist for many months or there may be temporary improvement followed by a relapse. In most of the refractory cases there is a chronic infection of some of the glands of Littre or a lacuna. When there is marked peri-glandular inflammation a soft stricture frequently ensues. These are treated by repeated instrumental dilatation and irrigation of the urethra for many weeks.

The treatment of chronic prostatitis and seminal vesiculitis consists of measures directed to improve drainage such as regular prostatic and vesicular massage, rectal diathermy, and urethro-vesical irrigations with pot. permang., flavine, or mercury oxycyanide in a 1 in 8,000 solution. Chemotherapy with sulphonamides is most useful in chronic gonorrhoea when drainage has been re-established. Vaccine therapy, particularly with an autogenous vaccine of the mixed bacterial flora, is also beneficial.

Stringent tests are required before a case is to be considered cured. These include the absence of urethral discharge for eight weeks and the urine should be free from pus cells and gonococci after the cessation of treatment and after provocative measures such as alcoholic drinks, hard exercise, the injection of a large dose of a gonococcal vaccine, prostatic massage and the dilatation of the urethra with a metal bougie. The prostatic fluid, and the semen if obtainable, should be

free from pus cells and gonococci. The gonococcal complement fixation reaction should be negative.

GONORRHOEA IN THE FEMALE—The sites of infection in the female are the urethra, vulva, and cervix, and in most cases all these are involved. The symptoms are vaginal discharge, painful and frequent micturition, and swelling of the labia. The urinary meatus becomes red, swollen and everted, pus can be expressed from the urethra by digital pressure along the anterior wall of the vagina. Chronic urethritis is frequently due to the infection of minute ducts near the orifice (Skene's ducts). Further extension of infection results in gonococcal cystitis and rarely in pyelitis.

Acute infection of the cervix results in a swollen injected os from which thick tenacious yellow pus issues and the vaginal walls are bathed in pus, in the chronic stage erosions of the cervix are frequent. Bartholin's ducts and glands are frequently infected. Further extension of infection is followed by endometritis and salpingitis. Localised peritonitis of plastic type is a frequent accompaniment but general spreading peritonitis is rare.

The rectum may be occasionally infected by the vaginal discharge and unless giving rise to prominent symptoms, this is often overlooked. Gonococcal infection may become chronic in the urethra or cervix, producing few or no clinical signs, and may cause gonorrhoeal iritis and arthritis. *Trichomonas vaginalis* infestation may coexist with gonorrhoea or may produce a similar discharge.

Female children, especially infants are particularly liable to become infected from bed clothes or towels. The infection produces a vulvo vaginitis in which the vulva, hymen and lower vagina are affected. In the acute stages there is much swelling, pain and purulent discharge. The urethra and rectum are frequently infected. Extension to the uterus or Fallopian tubes and localised peritonitis are rare. Joint lesions or iritis are very rare.

Treatment—General measures are similar to those for men. In acute vulvitis and acute endocervicitis treatment with hot sitz baths is advisable and rest in bed essential. In subacute and chronic conditions the cervix and urethra are treated by applications of various antiseptic solutions, *e.g.*, silver proteinate 5 to 10 per cent. Soluble pessaries for the urethra as well as the cervix are frequently used containing silver proteinate, flavino or ichthyol, and glycerin.

When the acute stage is subsiding vaginal douches of warm solutions of chloramine T (1 in 5,000) or potass permanganate

(1 in 8 000) are of value but only when given by a nurse or a very intelligent patient. Irrigation of the urethra as in the male is also employed.

Acute salpingitis which is indicated by pyrexia and pain in the lower abdomen associated with an enlarged and tender Fallopian tube is best treated by rest in bed in the Fowler position, radiant heat or hot fomentations and frequent hot vaginal douches. The development of pyosalpinx or general peritonitis may require surgical intervention.

Sulphonamide compounds are of use in all stages. Gonococcal vaccines are sometimes beneficial in the chronic stages.

Relapses after apparent recovery are common, especially when stringent tests for cure have been omitted. These should include the gonococcal complement fixation reaction and repeated microscopic examinations and cultures of the secretions of the urethra and cervix especially following menstruation.

In many cases the vulvo vaginitis in children is cured with sulphapyridine (0.25 gramme daily for four days).

Gonorrhœal Ophthalmia and Ophthalmia Neonatorum — Infection of the conjunctiva is caused by accidental transference of gonococcal pus into the eye and is frequent during transit of the new born child through infected maternal passages. An acute purulent inflammation results often with destructive ulceration of the cornea and finally, blindness. Excellent results have followed the use of sulphapyridine. One per cent silver nitrate solution is a successful prophylactic measure.

METASTATIC GONOCOCCAL INFECTION

Septicæmia is rare. When this occurs there is hectic fever, with enlargement of the spleen and purpuric rashes. Gonococci may sometimes be cultivated from the blood and the spleen. Acute bacterial endocarditis and pericarditis are almost invariably fatal.

Gonococcal iritis and irido cyclitis occur in chronic gonorrhœa and are usually associated with chronic disease of the prostate or seminal vesicles in the male, and cervicitis or salpingitis in the female. Both eyes tend to be affected successively, and recurrences are frequent. Arthritis is often present in these cases.

Gonorrhœal Rheumatism — The gonococcus shows a special tendency to attack the joints, tendon sheaths and bursæ. Such infections occur during the acute or chronic stage of gonorrhœa in about 5 per cent of cases. In the chronic stage there may be no symptoms of local infection, but

thorough examination will reveal a focus in the genito-urinary passages.

In acute arthritis, which rarely ensues before the third week of the disease, the onset is sudden with marked swelling of the joint chiefly affecting the peri-articular structures; effusion into the joint cavity is usually small in amount. There is considerable constitutional disturbance and the patient is feverish and sleepless from pain and tenderness. Considerable and sometimes rapid wasting of the adjacent muscles may take place. When the swelling subsides and in the subacute variety associated with chronic gonorrhoea the plastic inflammation involving the peri-articular structures frequently causes fibrous ankylosis. Acute arthritis is often limited to one large joint such as the knee or wrist, but cases of acute polyarthritis are met with in which several large joints are affected, together with the joints of the carpus or tarsus and interphalangeal joints. Infections of the temporo-mandibular or sterno-clavicular joints are not particularly common in gonorrhoea, but they rarely suffer acutely in any other infection. Spondylitis is occasionally of gonococcal origin.

Gonorrhoeal rheumatism may be limited to fleeting joint pains without physical signs, and also occasionally causes a chronic hydrops of one large articulation, such as the knee, which may persist for many years. The tendo Achillis with its underlying bursa may become inflamed also the plantar fascia resulting in a painful flat foot or painful heel.

Treatment.—Attention to the local focus of disease in the genito-urinary tract is essential. Considerable benefit may follow the administration of sulphonamido compounds.

In the acute stage when pain in the joint is marked splints may be required but on account of the tendency to ankylosis early movement should be encouraged. Local application of radiant heat or kaolin poultice is beneficial. In subacute arthritis fever therapy is often followed by improvement. In the more chronic stage the arthritis may respond to a gonococcal vaccine. Prolonged treatment by massage and exercises is essential for complete recovery. Pyarthrosis is rare and requires surgical intervention.

LYMPHOGRANULOMA INGUINALE

Lymphogranuloma inguinale or Climatic Bubo is a specific virus disease involving the inguinal glands and characterised by chronic suppuration with multiple sinuses. The infection,

which is of venereal origin, is frequent in tropical areas but uncommon in Europe

The transient primary lesion appears as a minute erosion or papule, usually situated in the coronary sulcus of the penis within two weeks after coitus. Two to three weeks later a painless swelling of the inguinal glands appears in one or both groins. The rate of development of the bubo is variable.

In the earlier stages of the adenitis the overlying skin assumes a bluish violet tint and becomes adherent to the glands, the surrounding tissues become infiltrated and hard. Multiple points of suppuration occur and discharge yellow tenacious pus. There also may be swelling of the iliac glands.

The general symptoms, which are variable, include fever, pains in the limbs, loss of weight and general prostration. Severe headache may occur with transient meningismus.

The systemic symptoms last a short time, but the bubo usually forms slowly and the resultant sinuses may drain for months.

In women proctitis is frequent, and a rectal stricture may be present in long standing cases.

Elephantiasis vulvæ may follow if the lymphatic channels be extensively obstructed. The typical inguinal adenitis seen in the male is uncommon in women.

The intracutaneous reaction of Frei becomes positive in almost all cases of lymphogranuloma inguinale in two to three weeks and may persist for many years after recovery.

Treatment—Excellent results in the early stages have followed the use of oral sulphanilamide and sulphapyridine. In the later stages response is slow and several courses of treatment may be needed. Local aspiration or partial excision of the bubo is occasionally required but is best avoided.

SYPHILIS

Syphilis, or lues, is a chronic infective disease due to the entrance into the body of a specific protozoon—the *Spirochæta pallida* (*Treponema pallidum*).

The duration of the disease is long, it may affect all organs and tissues of the body, and manifestations may appear at intervals over many years interspaced with periods of latency. Its natural occurrence is limited to the human race but it can be transmitted experimentally to apes and rabbits.

Congenital syphilis is due to the infection of a child by the transmission of the disease from the mother during pregnancy.

The clinical course of the acquired infection has been divided into three stages which are separated by intervals. The stage of the initial lesion is known as the primary stage that of generalised tissue reaction as secondary syphilis and that of the later recrudescences as tertiary syphilis.

Ætiology—Syphilis is due to infection of the tissues with the *Spirochæta pallida*, a protozoon discovered by Schaudinn and Hoffmann in 1905. This organism is slender, motile and of varying length 5 to 25μ and about 0.25μ in width. The spirals are regular, closely twisted and vary from ten to thirty in number. Its movements of progression are slow but those of rotation and of bending are rapid. Exposure to heat or absence of moisture is soon followed by the death of the organism.

From the lesions of the primary and secondary stage the *Spirochæta pallida* is readily isolated but in the tertiary lesions they can be found only with difficulty. In congenital syphilis spirochetes are often present in enormous numbers in the viscera such as the liver, spleen, and suprarenals.

ACQUIRED SYPHILIS

MODI OF INFECTION—Infection usually occurs through some minute abrasion on the genital organs during sexual intercourse with an infected person in whom there is an active syphilitic lesion, or spirochetes may be present in the seminal fluid or vaginal secretion of infected persons. At the site of inoculation after an interval of about a month a lesion known as the primary chancre appears.

Contact with infective material may result in extra genital chancre e.g., lip, mouth, finger, or nipple. Generalised secondary syphilis without any primary lesion has followed blood transfusion from syphilitic donors.

The infectivity of syphilitic lesions varies considerably being most marked in the secretion from the chancre and from the moist lesions of the secondary stage. In the tertiary lesions the infectivity is decidedly less.

THE PRIMARY STAGE—The inoculation by the infecting organism is followed after an interval usually of about a month by the development of a syphilitic chancre at the site of inoculation. The initial lesion is a minute papule which within a few days becomes eroded and gradually indurated at its base, at the end of a week or so a typical hard syphilitic chancre is present. This lesion is a small painless indolent

oval or round sore with a firm button like indurated base and sloping borders it is raw ham in colour and is covered with a serous discharge. Many variations from the typical hard chancre are met with but in all of them some degree of induration is present although it is much less evident in lesions in the female sex.

In the secretion from the deeper parts of the primary sore spirochaetes are found on dark ground microscopy.

Syphilitic chancres are usually solitary but may be multiple. In men the most common sites are the prepuce the glans penis and the frænum. A chancre or a soft sore may be concealed by phimosis but the former can be felt through the œdematous prepuce. Multiple syphilitic fissures on the preputial margin are not infrequent these like the uncommon mercurial chancre are usually painful.

In the female chancres occur on the labia which may be much swollen on the clitoris the urinary meatus the fourchette and the cervix.

Shortly after the appearance of a genital chancre the inguinal glands undergo a hard discrete painless enlargement. A similar enlargement of the posterior cervical epitrochlear and axillary groups soon follows.

The invasion of the blood stream by spirochaetes takes place during the incubation period and has already occurred before the chancre appears thus evasion of the primary chancre cannot prevent general dissemination of the disease.

In the untreated chancre the induration gradually subsides within about two months and may leave only a minute and superficial scar. At the time of the appearance of the chancre the Wassermann reaction is negative and remains so until two to three weeks have elapsed.

Various sores other than syphilitic chancres are met with on the genitalia. Infection with *Ducroy's streptolacillus* resulting within a few days in one or more chaneroid ulcers (soft sores) is common in tropical countries but infrequent in Britain except in seaports they are rare in women. Chaneroid ulcers are characterised by their irregular deep ulceration undermined edge sloughy floor and tenderness. The ulcer feels soft until healing is well advanced. Although chaneroid produces no constitutional effects swelling of the inguinal glands is a common feature. The swollen glands gradually become adherent to each other and to the skin forming a red painful swelling in one or both groups. Syphilitic glands rarely become matted and suppuration is exceptional whereas in the chaneroid bubo both are frequent.

The infection responds well to sulphapyridine and often to a vaccine of Durey's bacillus, neither of which improve a syphilitic chancre.

Simple erosions in the genital area may be caused by balanitis xerotica or herpes genitalis. Carcinoma of the penis is often mistaken for a chancre.

THE SECONDARY STAGE—Within four to six weeks of the appearance of the primary sore, the stage of general tissue reaction known as secondary syphilis, becomes manifest. Constitutional disturbances such as slight fever, loss of appetite, headache, malaise, alopecia and pains in bones and joints may occur, and anemia may be severe.

Cutaneous Eruptions—The main characteristics are symmetrical distribution, polymorphism, a lilac or ham colour, and lack of irritation. The types commonly met with may be classified as follows—

1 *A Roscolar Eruption* is the earliest and most frequent type, consisting of numerous pale rose or lilac macules on the trunk and flexor surfaces. There is a superficial resemblance to the eruption of measles and when the rash fades it leaves a reddish-brown stain on the skin, which may persist for some time. The roscolar rash must be distinguished from other erythemata, pityriasis rosea, and drug rashes.

2 *Papular Eruptions* which follow on the roscolar rash may be of the lenticular or follicular varieties. In the lenticular type the papules vary in size from a pinhead to a threepenny piece, are of round or oval contour, and of a reddish brown colour. Although more scattered, their distribution is similar to that of the roscolar rash. On the forehead they are termed the *corona tenebris*. In dry localities the papules become scaly and may resemble psoriasis.

3 *Condylomata*—In moist situations, such as the perineum and axillæ, the papules are more profuse in growth, and become sodden, these are known as condylomata, the moist surfaces of which are usually teeming with spirochetes.

4 *Rupia*—In debilitated patients infection of some of the papules with pyogenic micro organisms may occur, and the surface becomes covered with a dark crust under which a shallow ulcer soon forms. Dried layers of pus add to the crust forming a lumpet shaped scab known as syphilitic rupia.

5 *Follicular Syphilides*—These occur around the hair follicles and sebaceous glands, and may simulate acne vulgaris, they frequently become pustular.

Mucous Membranes—A bright erythema of the palate and fauces is met with early in the secondary stage. Superficial

formation may result in fibrous or bony ankylosis. The disease usually affects one large articulation, generally a knee or ankle, but other joints, including those of the spine, may be involved. The simulation of a tuberculous arthritis is close. Charcot's joint or tabetic neuro arthropathy is a degenerative condition not due to articular syphilitic disease.

Visceral Syphilis.—Syphilis of the liver is described on p 464. Syphilis may affect the kidneys in the tertiary stage by producing a condition of chronic diffuse parenchymatous nephritis which responds well to antisyphilitic treatment. The testes are often affected with a diffuse gummatus orchitis producing a solid heavy enlargement devoid of sensation.

Ulceration in the rectum in women eventually forming a stricture was formerly considered to be frequently of syphilitic origin. These conditions now appear to be due chiefly to gonococcal pelvic cellulitis and proctitis, or more rarely lymphogranuloma inguinale.

Tertiary lesions are common in the mouth, especially in men. In chronic superficial glossitis, which is very frequently of syphilitic origin, the surface of the tongue presents irregular white patches. This is known as *leukoplakia*. Sometimes it is lobulated from a deeper contracting sclerosis of syphilitic origin, between the lobules fissures develop which are often the precursors of carcinoma lingue. Isolated gummata, which are situated more deeply, occur in the centre of the tongue, and frequently ulcerate. The latter respond readily to anti-syphilitic treatment but leukoplakia rarely improves.

In the palate, fauces, nasal cavity, pharynx, larynx, and œsophagus ulceration may be extensive simulating lupus or a malignant ulcer.

Syphilis of the cardio vascular system is described elsewhere (*vide* p 575).

Asymptomatic Neuro-Syphilis—In this phase, although there are no physical signs or symptoms of involvement of the central system examination of the cerebrospinal fluid will reveal some abnormality indicative of a persistent syphilitic process. Asymptomatic neuro syphilis may be present in the latent or tertiary stages of syphilis, and may occur with or without other syphilitic manifestations. It is a phase of considerable importance because it is the precursor of clinical neuro syphilis, and because its early recognition and treatment may prevent the onset of tabes dorsalis or general paralysis of the insane. Asymptomatic neuro syphilis should be suspected in cases whose blood Wassermann reaction remains persistently positive in spite of full treatment, in those treated

cases who suffer a serological relapse and in all cases of latent syphilis. In these cases examination of the cerebrospinal fluid, including the cell count, globulin and protein estimation, Wassermann reaction and Lango reactions is imperative.

This symptom free phase may last from one to ten years or more during which period the pathological changes in the cerebrospinal fluid are gradually progressing in degree. At first protein and cellular changes are slight in degree the Wassermann test is negative or slightly positive and the Lango reaction shows slight positive changes. Later both cell number and protein content show a decided increase the Wassermann reaction becomes markedly positive and the Lango test approaches the luetic or paretic zone.

CONGENITAL SYPHILIS

Congenital syphilis is an infection that is acquired *in utero* from the mother, usually in the later months of pregnancy, and is strictly speaking not an inherited disease. Owing to the nature of the attachment of the foetus to the uterus congenital syphilis shows no stage comparable to the primary stage of acquired syphilis but is generalised from the onset. Spirochaetes are present in profusion in the liver, spleen, adrenals, lungs, and many other organs.

The syphilitic baby is usually apparently healthy at birth but within two to six weeks it begins to lose weight, becomes thin, wrinkled, and sallow, and shortly after shows eruptions on the skin and mucous membranes. A muco-purulent discharge from the nose known as "snuffles" begins in three to four weeks, and interferes with the development of the nasal bones, resulting later in the "saddle nose" deformity.

Cutaneous Lesions—Rashes are one of the commonest manifestations of congenital syphilis, occurring in 60 per cent of cases, they appear from three to eight weeks after birth. They are protean in character, and may be erythematous, macular, papular, or vesicular, of these, the scaly macular eruption is the most frequent. Their colour varies from a yellowish tinge to a coppery or raw ham tint. They may be scanty or profuse and are usually well marked on the buttocks, flexor surface of the limbs, and face. Whilst chiefly dry and scaly, they are apt to become eczematous in the nape area. Condylomata are frequent around the anus. The rare pemphigus eruption occurs early and may be present at birth. It consists of sero-purulent bullae, well marked on the palms and soles,

and produces a severe general reaction often with a fatal termination. Mucous patches in the mouth or on the fauces are common.

Rhagades are fissures appearing on the margins of the lips which follow circum-oral syphilitic eczema and leave permanent scarring. The larynx may be the seat of syphilitic inflammation causing a hoarse cry.

Bone Lesions—These are common and occur early. Pseudo paralysis of infants is caused by an acute epiphysitis termed osteochondritis syphilitica which attacks the end of a long bone most frequently the humerus radius or ulna, it produces tender swelling of the neighbouring joint and varying degrees of loss of power in the limb. Acute or chronic periostitis of the shaft is very common at any age and may give few clinical signs. X ray examination is a valuable method of diagnosis. Syphilitic dactylitis of the phalanges or metacarpals results in a fusiform swelling.

In the skull hypertrophy of spongy bone at the edges of the anterior fontanelle gives rise to Parrot's nodes a condition which when well marked, is termed the hot cross bun skull but is not characteristic of syphilis alone. Craniotabes a parchment-like thinning of the parietal and occipital bones is frequent in syphilis but is also met with in other debilitating diseases such as rickets.

Visceral Lesions—In the early months of infancy there may be marked enlargement of the spleen and liver. Renal infection may be shown by the presence of blood, albumin, and casts in the urine. Paroxysmal hæmoglobinuria is frequently due to congenital syphilis. White pneumonia usually in still born children is an interstitial fibrosis of the lung of syphilitic origin. The testicles in infancy may undergo bilateral painless enlargement frequently followed by atrophy. Disseminated choroiditis or optic neuritis followed by atrophy may be present in infancy, but both are rare.

DELAYED CONGENITAL SYPHILIS—If the infant survives there is a latent period between the lesions of infancy and those of later childhood comparable to the latent period in acquired syphilis or the early manifestations of syphilis may be absent. During this interval the child may develop normally, or be stunted in growth and backward in mentality, later, various lesions may follow.

Lesions of bones and joints are of frequent occurrence, syphilitic periostitis is particularly common and in the tibia produces characteristic irregular nodes on the anterior surface of the heavy thickened and forward curved tibia—the sabre-

blade tibia This condition is bilateral, although the changes may be more advanced on one or other side Periostitis gives rise to general or nodular enlargement of the clavicle, or localised swellings on sternum, skull, or bones of the forearm and leg Dactylitis may occur later as well as in infancy Symmetrical painless synovitis of the knee joints known as Clutton's joints, are met with about puberty, gummatous synovitis simulating tuberculosis of a joint is less frequent

The eyes are liable to chronic interstitial keratitis at any age up to and including adult life, but most frequently between six and sixteen years The condition is bilateral and usually affects one eye before the other, the cornea appears opaque resembling ground glass, and ciliary congestion is marked Vascularisation of the cornea gives rise to the "salmon patches" Fair recovery usually takes place after the condition has lasted from one to two years, but relapse is frequent Iritis, choroiditis or retinitis may coexist, leaving permanent changes and interference with vision

Neuro-syphilitic lesions may occur in congenital infection Juvenile tabes and general paralysis occur in adolescence, comparable to similar lesions in acquired syphilis The cerebrospinal fluid is abnormal in from 20 to 40 per cent of all cases of congenital syphilis Meningo vascular conditions also occur, and congenital syphilis is considered to be sometimes a causative factor in epilepsy, unbecility, spastic diplegia, and hydrocephalus Nerve deafness occurs about puberty, the condition is bilateral and frequently complete and permanent

Cutaneous manifestations, which resemble those of the tertiary stage in acquired syphilis, are seen in late childhood Favourite sites are the face, especially around the nose and the mouth, and the skin over the sternum, ribs clavicle, and front of the leg They are chronic, frequently ulcerate, and extend slowly, healing in the centre and simulating tuberculous lesions Ulceration of the hard and soft palate is frequent, and in the larynx may cause severe stenosis on healing

The milk teeth frequently exhibit imperfections, but none that are characteristic of congenital syphilis The permanent teeth, however, show striking changes, especially in the upper central incisors, which are known as *Hutchinson's teeth* There may be irregular erosions in the cutting edge or irregular atrophy, but a typical example presents a single clearly marked crescentic notch in the cutting edge, and the tooth is peg shaped, short, and narrow

The early cutaneous lesions of congenital syphilis are infective, in later years the infectivity is very slight, but syphilis

has been shown to be transmitted to the third generation although such cases are very rare

SYPHILIS AND PREGNANCY

Acquired syphilis in women, apart from pregnancy, runs a milder course than that in men. Syphilis associated with pregnancy however undergoes considerable modifications. When acquired at the time of conception or during the course of pregnancy there is frequently an inhibition of the early stages, no primary stage is noted and secondary lesions are either slight or absent. This latency as regards the mother may persist until the menopause after which the various tertiary syphilides may become manifest. The majority of these patients have a positive Wassermann test, but this may vary during pregnancy. A positive Wassermann reaction given by the umbilical cord blood is an indicator of infection in the mother and not necessarily in the infant.

The child may suffer from severe syphilis even though the condition be latent in the mother. As a rule, the earlier pregnancies result in syphilitic still births, later pregnancies produce living but syphilitic children, and ultimately a normal child may result. The infectivity of the mother to the foetus varies in an unaccountable manner, and it is not uncommon to see in a large family a healthy child interposed in age between others bearing manifestations of syphilis.

A child suffering from active congenital syphilis does not infect its mother although a healthy nurse may become infected. This observation, known as *Colles's law*, depends on the fact that the mother is already syphilitic, usually in the latent stage and cannot be reinfected. Although there are frequently no clinical signs in the mother the Wassermann reaction is very often positive.

THE WASSERMANN REACTION

During the course of syphilis certain changes take place in the blood as a result of its reaction to the presence of spirochaetes. These are indicated qualitatively, and to some extent quantitatively, by the reaction known as the Wassermann test. Positive results are met with in yaws and in leprosy, but in England a positive result to this test almost invariably indicates syphilis, a negative result, however, as will be noted later, does not invariably exclude syphilis.

In the stage of incubation and in the earlier part of the

primary stage the reaction is negative, a positive result being rarely found before fourteen days after the appearance of the primary lesion. From this time until the manifestations of the secondary stage appear there is a gradual increase in the percentage of positive results, the reaction being most markedly positive in the florid stage of secondary syphilis.

In the latent and tertiary stages of the disease the Wassermann test is positive in 60 to 70 per cent of cases.

The Wassermann test in congenital syphilis with active lesions is positive in 90 per cent of cases, in the stage of latency the occurrence of a positive reaction is less frequent, and after puberty tends to disappear. Following the administration of arsenical remedies, the Wassermann reaction may become negative and remain so, provided treatment is both early and efficient.

Various flocculation serum reactions, in which the mixing of syphilitic serum with an alcoholic extract of heart muscle produces visible flocculi, are now also employed in diagnosis. The Kohn reaction which is most generally used in this country, is slightly more sensitive than the Wassermann reaction.

THE TREATMENT OF SYPHILIS

The modern treatment of syphilis by arsenical compounds bismuth and mercury, is followed by extremely favourable results, provided that it is commenced in the early stage and maintained regularly. Any delay in the institution of treatment renders cure less likely. The results of treatment commenced in the sero negative primary stage are overwhelmingly superior to those begun in any later stage, it is, therefore, of the utmost importance to establish the diagnosis of syphilis before the advent of a positive Wassermann test, and this can only be done with certainty by finding *spirochæta pallida* in the serum expressed from the primary lesions.

Since the introduction of the original salvarsan (606) by Ehrlich in 1910 and of neosalvarsan (911) a few years later, syphilis has been treated mainly by compounds of this type. The compound most frequently in use at the present time is neoarsphenamine, an organic arsenical compound containing about 20 per cent of arsenic. Although the efficiency of this compound is slightly less than that of the original salvarsan its decreased toxicity and ease of administration have led to its general use.

Neoarsphenamine is manufactured under various names,

eg, novarsenobdion (N A B), novostib, neokharivan and neosalvarsan

Arsphenamine is manufactured under the name of arsenobillon, salvarsan, and kbarsivan. Of the arsphenamine preparations the only one in common use is stabilarsan, which is a combination of the arsphenamine base with glucose, and, like the neoarsphenamines, may be given intravenously in a concentrated solution.

Bismuth and less frequently mercury are also used in the treatment of syphilis in conjunction with the organic arsenicals. Recent work has shown that the action of bismuth is superior to that of mercury. Numerous preparations of bismuth are advocated of which the metallic suspensions or bismuth oxychloride are the most suitable.

Mercury by injection is now little used but is frequently given orally as *liquor hydrargyri perchloridi drachm 4 1* or *pulvis hydrargyri cum creta grains 1 5* in the later stages.

In cases of primary and secondary syphilis a neoarsphenamine preparation is administered without delay. This is injected intravenously in a 10 per cent solution in cold sterile distilled water not sooner than two hours after a meal.

For men of average weight and otherwise in good health the initial dose is 0.45 gramme. This is followed by eight weekly intravenous injections of 0.6 gramme increasing to 0.75 gramme in men over eleven stone in weight.

Each week during this treatment a bismuth preparation equivalent to 0.2 gramme of bismuth metal is injected into the muscles of the buttock. The bismuth may be given on the same day as the intravenous injection but an interval of three to four days is advisable.

In women the average initial dose of neoarsphenamine is 0.3 gramme and subsequent doses should not exceed 0.6 gramme. For men or women of less than average weight, or in slightly impaired health from concurrent disease, the individual dosage is slightly reduced.

Such a series of injections constitutes a course of treatment. After an interval of four weeks a second similar course is administered followed by a similar rest interval. Iodides are given during the intervals.

A Wassermann test is done at the beginning of each course. In all at least four such courses should be given to cases in which the Wassermann reaction is negative after the first course.

A small proportion of cases will fail to become negative after as many as six courses. Before prolonging treatment

attention should be paid to the general health and to signs of syphilitic involvement of the central nervous system

When intravenous injection is difficult or in cases of mild general intolerance the treatment may be continued by intramuscular injections of sulpharsphenamine compounds, e.g., sulphostab, kharsulphan or sulfarsenol, 0.3 to 0.15 gramme

When intolerance to arsenical compounds by any route is evident, prolonged courses of bismuth treatment are resorted upon and in such cases the rapidly absorbed oil soluble bismuth compounds are indicated. The use of bismuth over long periods may cause aluminuria or stomatitis. The latter is usually dependent upon associated pyorrhœa. Any dental sepsis should be attended to at the beginning of treatment

During pregnancy intravenous injections of neoarsphona-mine and bismuth therapy are well tolerated and can be administered up to the eighth month, the risk of abortion is very slight. With efficient treatment throughout pregnancy there is a minimal risk of congenital disease in the child

Congenital Syphilis—Syphilitic conditions arising early in infancy respond well to organic arsenical compounds and bismuth. The function of mercury is also of value. Treatment follows the same general lines as in adults. The toleration of infants and children for these remedies is excellent. In infancy the disease is treated with sulpharsphenamine compounds by intramuscular injection. Intravenous injection is difficult and less suitable for children under the age of five

Sulpharsphenamine (sulphostab, kharsulphan, or sulfarsenol) may be given to an infant a few weeks old in weekly doses of 0.005 gramme. For severely affected or premature infants oral treatment with stovarsol (orarsin) tablets is more suitable. This arsenical compound may be given, in milk, in daily doses of 6 mgs per lb body weight in the first week of treatment increasing up to 12 mgs per lb body weight in the fourth to the ninth week of treatment

In less severely affected infants treatment may be commenced with sulpharsphenamine. For an infant a month old the initial amount is 0.01 gramme, increasing each week by graduated amounts to 0.05 gramme at the end of the course of ten weekly injections

A few weeks later a bismuth preparation e.g., a metallic bismuth suspension or bismuth oxychloride is injected into the gluteal muscles in weekly amounts equivalent to 0.02 gramme of bismuth metal for twelve weeks

Older children require larger amounts of these remedies. For a child one year old and of average weight ten weekly

injections of sulpharsphenamine are advisable increasing gradually from 0.025 to 0.1 gramme. This is followed after a few weeks' interval by the equivalent of 0.04 gramme of bismuth metal in each of twelve weekly injections into the buttock.

Since children suffering from congenital syphilis are frequently debilitated and underweight the amounts to be given of these remedies should be considered in terms of weight rather than of age. In general after the age of three months children of any age can be given 0.005 gramme of sulpharsphenamine for each pound weight as the maximum weekly amount for a series of injections. Initial amounts should be about 0.002 gramme for each pound of the child's weight.

Thus for a child weighing 30 pounds the initial injection should be 0.05 gramme and the maximum amount 0.15 gramme. For a child of 75 pounds weight the initial amount should be 0.15 gramme and maximum amount 0.375 gramme.

The continuation of each course and the progressive increase in dosage depends upon the improvement in the local and general condition, a progressive gain in weight and the absence of intolerance to these remedies.

The courses of arsenical treatment are followed after a few weeks' interval by a series of ten to twelve weekly injections of bismuth. At the age of three to six months amounts equivalent to 0.02 gramme of metallic bismuth increasing to 0.03 gramme are given. As an approximate guide to dosage the equivalent of 0.01 gramme of metallic bismuth for each five pounds of the child's weight may be considered as a maximum dose. Mercury should not be given during bismuth therapy.

Potassium iodide is not well tolerated in infancy. *Syr. Ferri Iodidi* minus 5 t.d.s. is preferable. The green iodide of mercury $\frac{1}{4}$ to $\frac{1}{2}$ grain is also used.

The treatment of congenital syphilis is prolonged for at least three to five years. The child must be subjected to close periodic clinical and serological observation until after puberty. *The cerebrospinal fluid should be examined in all cases with a persistently positive Wassermann reaction in the blood after three years' treatment.*

Treatment of Tertiary Syphilis—The general condition of the patient and in particular the state of the lungs, heart, liver and other vital organs must be considered. In these late cases much harm to the general health may be caused by injudiciously intensive treatment with organic arsenical remedies at a time when the complete eradication of syphilis is probably impossible. The main object of treatment at this stage is to keep the patient

reasonably well and not to attempt to sterilise the tissues, possibly at heavy cost to the general health.

In general, treatment should be mild in intensity but prolonged. Potassium iodide, 30 to 60 grains daily, has a marked absorptive action on gummatus deposits. Neosarsphenamines are given, only after preliminary iodide therapy, in small or moderate amounts at intervals of one or two weeks. Intravenous injections should not be given to patients over sixty years old. Arsenic and bismuth injections are given in separate courses.

A pregnant woman suffering from syphilis in any stage requires intensive treatment if the health of the child is the main consideration.

Gummatous lesions of the skin, mucous membranes and soft skeletal structures react readily to treatment. In visceral *gummata* there is a rapid initial effect but final resolution may be slow. The effect of treatment upon the late syphilitic affections of bone is very slow although symptoms may disappear promptly. Elderly patients suffering from tertiary syphilis whose indifferent health is partly due to additional causes are best treated by the prolonged use of bismuth injections and the oral administration of mercury and iodides.

The treatment of cardiovascular syphilis and neurosyphilis is dealt with elsewhere (*vide p. 576 and p. 802*).

THE TOXIC EFFECTS OF THE ORGANIC ARSENICAL COMPOUNDS

Various toxic effects following the use of salvarsan were reported soon after its introduction in 1910, and an attempt to reduce its toxicity without detracting from its efficiency has been one of the chief reasons underlying the production of neosarsphenamine and sulpharsphenamine.

The various toxic effects of these arsenical preparations themselves may be divided clinically into an early and a late group.

Early Reactions.—Nausea and vomiting, either during or immediately following an intravenous injection, are commonly met with; some hours later there may be mild diarrhoea or, rarely, transient jaundice.

Following the first or second intravenous injection there may occur, but rarely, a group of symptoms which has been termed "nitritoid crisis" or "vasomotor crisis." This reaction, which ensues during or immediately after the intravenous injection, consists of the sudden onset of dyspnoea, dilatation of the pupils, cyanotic flushing, and tingling of the hands and

feet which are followed rapidly by varying degrees of transient unconsciousness. Later œdema of the face, especially the lips and eyelids, may follow.

Transient cutaneous eruptions of general distribution, either erythematous or urticarial in type, may supervene at any time within the first two days after injection. Such reactions are likely to be repeated after further injections.

The most serious of these early reactions is encephalitis hæmorrhagica, which supervenes within twenty four to thirty six hours, this complication is very uncommon, but is usually fatal. Purpura hæmorrhagica is a rare toxic effect but even if mild is a warning of a dangerous idiosyncrasy to arsenic, such cases may develop aplastic anæmia.

Prevention and Treatment—Intravenous injections of anti-syphilitic remedies should not be administered within two hours of any heavy meal, and all solutions should be freshly prepared and administered slowly. The most efficient treatment for the vasomotor reaction is an immediate subcutaneous injection of 1 c.c. of a 1 in 1,000 solution of adrenalin.

The oral administration of one ounce of glucose, half an hour prior to the injection, is frequently practised as a prophylactic measure against hepatic damage.

Late Toxic Reactions—During active treatment over long periods, minor toxic effects such as general malaise, depression, and loss of weight may occur at any time.

Arsenical Dermatitis is usually an acute generalised eruption of the exfoliative type associated with intense irritation, in mild cases it may not progress beyond the erythematous or papular stages, in which case it is likely to be taken for a simple erythema, or, if papular, for lichen planus.

In the severe type an initial acute general erythema with some infiltration of the skin and mucous membranes is soon followed by the formation of vesicles and bullæ, the condition progresses rapidly into a state of acute weeping dermatitis, with crusting and exfoliation. Secondary infection of the raw surfaces is a common sequel, and abscess formation may take place in the axillary, inguinal, or cervical glands. The condition is protracted, and some of these cases are fatal from broncho-pneumonia or œdema of the lungs.

Unlike the earlier toxic reactions, arsenical dermatitis supervenes after some weeks or months of treatment.

Treatment—Complete rest in bed, application of calamine lotion or olive oil, and daily intravenous injections of 0.45 to 0.9 gramme of sodium thiosulphate. Scrupulous care should be taken in dressing any raw areas to avoid infection.

Jaundice—Whilst well known as one of the signs of secondary syphilis, jaundice may also be produced by the toxic effects of arsenical therapy. A mild jaundice is met with a few days after an injection, but the more serious intense jaundice occurs several weeks or even months after the end of a series of injections, and on account of this interval is often erroneously regarded as a catarrhal jaundice and not as a complication of the treatment. The more severe cases may pass into acute yellow atrophy of the liver with a fatal termination.

Recent investigation with hepatic function tests has shown that slight hepatic damage after the administration of arsenical compounds is much more frequent than the occurrence of jaundice would lead us to expect. The detection of a rise in the bilirubin content of the blood serum is an indication for the cessation of treatment, which may prevent the production of any further damage to the liver. Similarly, the appearance of excess of urobilinogen in the urine during treatment indicates hepatic damage.

Treatment—Rest in bed, mild purgatives and daily intravenous injection of calcium thiosulphate, 0.6 gramme.

Glucose should also be given orally, in the severe cases intravenous glucose is advisable.

V. T. LLOYD

TROPICAL DISEASES *

INTRODUCTION

ALL those diseases which are commonly met with in temperate countries are encountered also in tropical and subtropical climates. It is important to bear this constantly in mind so that the quest for tropical diseases shall not tempt the practitioner to overlook conditions which he would readily recognise at home. Except in epidemics and in particular areas it is unlikely that more than a small percentage of the patients who seek medical advice will do so on account of purely tropical disease.

It should be remembered too, that residence in hot climates has effects on the physiological processes of the body for which due allowance must be made and that a dual pathology is far more often present than in temperate climates. Thus an oliguria that would be pathological in a temperate climate may be physiological in the tropics while an attack of malaria is apt to light up other dormant conditions or alternatively, a malarial attack may be precipitated by some other illness such as pneumonia. Dysentery and malaria frequently coexist and may have many symptoms in common. ankylostomiasis may be only one of several causative factors in a case in which a microcytic anæmia is the chief feature, enlargement of the liver and spleen may be due to malaria and kala azar as well as to schistosomiasis while tuberculosis, syphilis, splenic anæmia, malignant disease etc., must still be borne in mind.

In no branch of medicine are preventive as opposed to curative measures so necessary or so successful as in the case of tropical diseases. The great majority of the incapacitating and killing diseases of the tropics is conveyed by arthropod vectors. In some the causative organism has an essential cycle of development in the arthropod in others the arthropod passes

* Helminthic infections, the dietary deficiencies, and effects of heat and climate are dealt with in other sections.

on the organism mechanically. In still other diseases water is the medium of infection. In all these conditions treatment of the individual who has become infected is a poor substitute for the attention to hygiene and sanitation that could have prevented such infection. For example the treatment of cases of malaria as they occur, necessary as it is is of little avail if nothing is done to control the mosquitoes that cause the disease, while dysentery will be wiped out not by treating its victims but by doing away with the insanitary conditions that alone enable it to claim them. It is by such hygienic measures that this country has been freed from typhus and cholera which were once a scourge and which have now been banished to those countries where ignorance and prejudice still enable them to survive. Some knowledge of the life cycles and habits of the various hosts and vectors and an acquaintance with the sanitary measures appropriate for their destruction or control are therefore essentials of tropical practice.

MALARIA

Malaria is the most important of all the tropical diseases being responsible for more than 3½ million deaths every year and for an incalculable amount of invalidism. Although far more common in tropical and subtropical countries it occurs also in temperate zones.

Ætiology—The disease is caused by protozoal parasites of the genus *Plasmodium* which are conveyed from man to man by female anopheline mosquitoes. Only three species of plasmodia are of importance *P. falciparum* causing malignant tertian (subtertian) *P. vivax* causing benign tertian and *P. malaria* causing quartan malaria. These plasmodia have two distinct cycles of development or multiplication. The asexual cycle takes place in the red blood cells of man and differs somewhat in the various species, causing fever at regular intervals corresponding to the duration of the cycle of the species concerned less than forty-eight hours in the case of *P. falciparum* forty-eight hours in the case of *P. vivax* and seventy-two hours in the case of *P. malaria*. During this cycle each infected red cell bursts and liberates eight to thirty-two young parasites each of which infects another cell and at the same time certain sexually differentiated forms (gametocytes) develop. The gametocytes alone are able to initiate the sexual cycle which occurs in the mosquito after it has fed on the blood of an infected person. The final products of the

sexual cycle (sporozoites), many hundreds of which are produced by each pair of gametocytes, are injected into man by the mosquito when it bites again and each sporozoite infects a red cell. The sexual cycle in the mosquito is similar in all species and takes about ten days.

Control of Malaria—For the occurrence and continued existence of malaria there must therefore be —

- 1 Vectors of the infection, female anopheline mosquitoes
- 2 Infected persons (having gametocytes in their blood) from whom the mosquito may derive its infection
- 3 Susceptible persons to whom the infection may be transmitted
- 4 Opportunities for the mosquitoes to bite both infected and susceptible persons

If any one of these essentials could be completely eliminated malaria would cease to exist. As this is impossible in practice control of the disease involves the prosecution of measures directed against all four, namely —

1 Anti mosquito measures directed mainly against the aquatic larval forms in their breeding places, oiling the surface of water, clearing streams, draining or filling in stagnant pools, screening wells and cisterns, etc. Indoors adult mosquitoes may be swatted and discouraged by fumigants.

2 Protection against mosquito bites by the regular use of mosquito nets, remembering that it is quite as important to protect the infected as the uninfected. Bright lights and draughts discourage mosquitoes as do the various strong smelling insecticides. Citronella oil applied to the skin will repel the insects for an hour or two. Shorts should be replaced by trousers after dusk, and these should be tucked into the socks unless mosquito hoots are worn. Ideally all living quarters should be screened by mosquito proof gauze.

3 Thorough treatment of all cases of malaria which would otherwise constitute a reservoir of infection and the taking of a daily prophylactic dose of 5 to 10 grains of quinine by persons resident in heavily infected areas. Actually this does not prevent infection since quinine is not lethal to sporozoites, but it often prevents or postpones clinical manifestations. The taking of prophylactic quinine is not justifiable as a routine procedure over long periods for everyone living in districts where malaria is endemic as it is apt to cause mental depression and dyspepsia. But when a person has important work to do in a highly malarious area and sickness must be avoided at all costs it is fully justified. It is most important that the quinine

should be taken regularly and that it should be continued for some time after leaving the area. Other drugs used in the treatment of malaria are too toxic for general use as prophylactics.

Pathology—In the acute stage of malaria, especially in subtertian, blockage of the capillaries of various organs by infected red cells causes local congestion, œdema and stasis. The rupture of numbers of infected red cells during each asexual cycle liberates, in addition to a new generation of parasites, hæmoglobin from the cells and a dark pigment from the parasite itself. This pigment possesses toxic and hæmolytic properties and there follows a progressive anaemia, toxæmia, hæmoglobinæmia and pigmentation of the cells and organs of the reticulo endothelial system. The liver and spleen enlarge as they attempt to deal with the products of hæmolysis, while the efforts at blood regeneration are reflected in the hyperplasia of the hæmopoietic tissues.

Symptoms—After an incubation period of one to three weeks or more the first bout of fever occurs. Onset is sudden, usually with a rigor, and occurs most commonly before mid-day. There are three well marked stages.

1 *The Cold Stage*—The patient shivers, the teeth chatter and the skin is blue and "goosey," and he piles on all the bed clothes he can find. There is headache and often vomiting. The sensation of cold is purely subjective as the temperature is already rising. This stage lasts for one or two hours.

2 *The Hot Stage*—The patient begins to feel hot and the headache grows worse. The bed clothes are thrown off, the skin becomes flushed and dry and the pulse full and rapid. The temperature rises to 101° , 103° or even higher. This stage lasts from three to four hours.

3 *The Sweating Stage*—Gradually the skin becomes moist, the patient breaks into a profuse sweat, saturating the bed clothes, and the temperature begins to fall. After two to four hours the sweating ceases, the temperature falls to normal, and the patient may feel so much better that it may be difficult to prevent his going to work.

In tertian malaria the attack recurs on alternate days until cut short by treatment, while in quartan malaria there are two clear days between attacks. When mixed or multiple infections are present this regular sequence is broken. Sometimes the rigor may be absent and one or other of the stages is shortened or lengthened.

In malignant tertian infections the onset is often insidious,

the rigor does not occur and the stages are less well defined. Pyrexial periods are prolonged and apyrexial periods shortened so that fever is often quotidian or remittent.

Malignant Malaria.—Any case of malaria is liable suddenly to develop pernicious symptoms and to kill the patient with hardly a warning sign. For this reason every case should be regarded and treated as an emergency. These pernicious cases occur most commonly in hyperendemic areas and at the most malarious season of the year and are nearly always due to infection with *P. falciparum*. They fall roughly into two main types—cerebral and algid.

The *cerebral type* may be characterised by hyperpyrexia up to 110° F. or more with wild delirium terminating in fatal coma. Sometimes coma may supervene without any warning signs; convulsions or pareses may occur and permanent mental changes may result.

The *algid type* causes shock, collapse and a tendency to fatal syncope. Gastric, dysenteric, pneumonic, hæmorrhagic and syncopal forms are recognised.

Two other types known as “typhoid remittent” and “bilious remittent” are less dangerous but are liable to be very difficult to diagnose and to treat.

These pernicious types are caused by obstruction of the capillaries of the various organs concerned by parasitised red cells.

Relapses.—About 50 per cent. of cases of malaria are likely to relapse even up to several years after the initial infection and even after the most thorough treatment. These relapses are caused by parasites which persist in the blood and especially in the spleen. Any cause of splenic contraction such as shock, cold, fright, and certain drugs is therefore liable to precipitate a relapse. Relapses occur far less frequently and over a shorter period following malignant tertian than is the case with benign tertian and quartan malaria.

Chronic Malaria.—After several relapses or reinfections malaria tends to become chronic. The spleen enlarges, often to many times its normal size, later becoming hard, fibrosed, small and of a “slatey” colour, the typical “ague-cake” spleen. The liver undergoes somewhat similar changes. There are cachexia and a sallow and jaundiced skin as the result of chronic anæmia, and a leucopenia with relative monocytosis is usually present. The general wasting and debility render the patient an easy prey to intercurrent disease.

Immunity.—There is no appreciable degree of natural immunity to malaria. A considerable immunity can be

acquired over a period of years but only at a great risk to life and as the result of prolonged illness

Diagnosis—Owing to the protean nature of malarial symptoms it may resemble almost any febrile disease, but enteric fever kala azar, amoebic hepatitis and the various short fevers such as sand fly fever and dengue are the most likely to be confused with it

Although malaria is often of all diseases the one in which an early and accurate diagnosis may be expected, yet in some cases especially subtertian or when quinine has been taken, parasites may be absent from the peripheral blood. In such cases treatment must be started at once without waiting for proof of the diagnosis. Such proof may not come in time to interest the patient and will be of little comfort to the relatives

If it has not been possible to make the diagnosis by blood examination, the response to quinine may supply it. When a fever continues in the absence of parasites and despite the administration of quinine, it is unlikely to be malaria. On the other hand there are many short fevers which will appear to respond to quinine, since the temperature drops in any case after two or three days whether quinine is given or not. Other acute fevers may occur in a patient with chronic or latent malaria, so that the discovery of parasites may not supply the whole diagnosis

Treatment—There are three drugs that are specific in malaria—quinine, atabrin and plasmoquine*. Broadly speaking the first two have a similar action in relieving symptoms and controlling the temperature by destroying asexual parasites quinine acting rather more rapidly than atabrin. Plasmoquine appears to reduce the liability to relapse and by a selective action on the sexual forms or gametocytes (especially of *P. falciparum*),—reduces infectivity to mosquitoes—an important point when treating cases in endemic areas. No one course of treatment can be laid down which is best or even suitable for every case 'but from what has been said it will be apparent that quinine or atabrin should be given in the acute stage and should be followed by plasmoquine

Quinine may be given concurrently or in combination

* Atabrin and Plasmoquine are synthetic preparations originally produced in Germany. They are now being manufactured in England under these and various other names. Atabrin—*Quinacrine Mepacrin* 1-ethyl chloride. Atabrin musonate (for intramuscular injection). *Quinacrine schulle*. Mepacrine methanesulphonate. Plasmoquine Itraquine Iamaquin

with either atabrin or plasmoquine indeed it seems to increase the efficacy and to lessen the toxicity of the latter but atabrin and plasmoquine should never be prescribed concurrently as each appears to enhance the toxicity of the other. If both drugs are available atabrin should be given first and a few days should be allowed to elapse before plasmoquine is started.

It should be borne in mind that all these drugs are toxic and that when they are administered in quantities sufficient to kill the parasites they are liable to have certain unpleasant and even dangerous effects on the patient. Quinine in therapeutic doses nearly always causes nausea and tinnitus while vomiting, palpitations, deafness and cutaneous eruptions may result. In rare cases of idiosyncrasy to the drug amblyopia and hæmoglobinuria may occur. Atabrin probably the least toxic of the anti malarial drugs often causes a yellow staining of the skin (not jaundice) and rarely abdominal pain. Plasmoquine may cause cyanosis due to methæmoglobinæmia especially if administered for more than five or six days at a time and should be used with very great caution in patients over forty. In alcoholics and in the subjects of hepatic or renal inefficiency plasmoquine should not be used.

Quinine should be given in solution and never in solid form. When given by mouth it is immaterial which salt is used but the sulphate requires the addition of acid to effect solution. Owing to its relative insolubility it is unsuitable for parenteral administration for which the bihydrochloride should be used. Quinine should except in very severe cases be withheld until the temperature has started to fall and each dose should be preceded by a dose of an alkaline mixture containing 60 gr. of sodium bicarbonate and 40 gr. of sodium citrate to lessen the risk of acidosis and cinchonism. Where the urgency of the case demands the immediate administration of quinine it also demands the more rapid absorption obtained by intravenous or intramuscular injection.

Treatment of Acute Malaria—An initial dose of calomel followed by salts should be given to open the bowels and keep the liver active and pure. A.P.C. should be administered to relieve headache and encourage sweating.

If quinine alone is available the following course is recommended —

10 gr. t.i.d. for a week with the patient in bed

7 gr. t.i.d. for a week

5 gr. b.i.d. for a fortnight with an iron and arsenic tonic

If other drugs are available a combined course should be given as follows —

Quinine 10 gr, three times a day until the temperature has been normal for forty eight hours

For the next five days atebnin one tablet (0.1 gm) three times a day. The tablets should be swallowed whole and should be taken after food

For the next two days no treatment

For four days plasmoquine one tablet (0.01 gm) three times a day and quinine, 5 gr twice a day. The same results may be achieved by using either plasmoquine compound or quinoplasmine both of which contain quinine as well as plasmoquine

This course may need to be repeated in part or in whole and should be followed by a period of light duty on an iron and arsenic tonic. It may need modification to suit individual cases. Alkalis and glucose should be given

Intravenous quinine may be given in very heavy infections in malignant malaria and in cases where the drug is not retained when given by the mouth. The dose is 10 gr, and it should be diluted in at least 10 c.c. of saline distilled water or 5 per cent glucose and injected slowly. Repetition is seldom necessary, further treatment being given by mouth

Intramuscular quinine has many disadvantages and few advantages over the intravenous route but when veins are collapsed or when the operator is inexperienced intramuscular medication may be preferable. Moreover the sudden destruction of such a large number of parasites as is effected by intravenous quinine may liberate a dangerous or even fatal amount of toxin into the blood stream. Intramuscular injections must be given deep into the gluteal muscles and great care must be taken to avoid the sciatic nerve. The dose is 5 to 10 gr of the bishydrochloride dissolved in 2 to 4 c.c. of sterile water or saline and may be repeated as necessary

Treatment of Chronic Malaria—Every attack of malaria whether it be a primary attack or a relapse, should be adequately treated as it occurs. If this is done there is rarely any justification for the prolonged courses of treatment that used to be prescribed in the hope that further relapses might thus be avoided. In very obstinate cases however drugs which cause splenic contraction may be used followed by quinine or atebnin to kill the parasites thus thrown into the blood stream. Ascoli's treatment consists of the intravenous injection of a tenfold dilution of 1:1000 adrenalin in amounts increas-

ing from 1 to 20 minims. Metallic salts are safer and equally effective, and neoarsphenamine given as follows has proved very successful. 0.45 gm is given intravenously followed by 10 gr of quinine in the evening. Next day 10 gr of quinine are given three times. This treatment is repeated weekly for three further weeks, then fortnightly for a month and monthly for four months. The treatment should be controlled by blood slides taken just before the first dose of quinine. The relapse time should be studied and the intervals between treatment modified accordingly. Atebrin may, of course, be used in place of quinine.

All cases of malaria must be nursed under a net and should receive a course of treatment immediately before arrival in a cold climate.

BLACKWATER FEVER

Blackwater fever is characterised by an acute hæmolysis of the red blood cells resulting in a hæmoglobinæmia and, when the renal threshold has been overcome, hæmoglobinuria or blackwater.

The geographical distribution is superimposed on that of malaria, but is far more limited, occurring only in certain of those areas where severe malaria is prevalent. The reasons for the localised distribution and for the occurrence of hæmolysis are not known. Although a few authorities still think that a specific organism (possibly tick borne) may be responsible, it is now generally agreed that malaria, especially severe and repeated attacks of subtertian, is the essential ætiological factor, and that all drugs that are specific in the treatment of malaria, especially quinine, may predispose to the condition. It is rarely seen in persons who have lived in endemic areas for less than a year but may occur within a year after leaving them. Quinine alone may cause hæmoglobinuria but not blackwater fever, and the disease has been reported in persons who have never taken quinine but it has never been known to occur in persons who have not lived in highly malarial districts. It may be stated with certainty that the disease nearly always follows heavy and repeated infections with subtertian malaria that have been irregularly or insufficiently treated, although it may not be possible to find malarial parasites in the blood once the disease has supervened.

The main symptoms are those of a malarial attack with severe and sudden hæmolytic anæmia which may involve 50

per cent of the red cells. There is usually vomiting and epigastric pain. The liver and spleen enlarge as the reticulo-endothelial system attempts to deal with the products of hemolysis. The urine, which is scanty with abundant albumen and casts, varies in colour from red to brown or black. By the fourth day the hemoglobinuria lessens and the temperature falls, but relapses may occur. Hyperpyrexia, delirium, persistent vomiting, hiccup, profuse diarrhoea and oliguria are bad prognostic signs. Mortality varies from 10 to 50 per cent.

There is no specific treatment. Careful nursing is of supreme importance, and the patient should be kept warm in bed and should not be moved. Repeated transfusions of compatible blood up to half a litre on each occasion should be given from the start when facilities exist. To guard against anuria and acidosis large amounts of fluid should be administered with massive doses of sodium citrate and bicarbonate. Hot fomentations may be applied over the kidneys and caffeine citrate in a dose of 2 gr. twice a day may be used as a diuretic. If symptoms are severe intravenous injections of glucose (5 per cent) or sodium bicarbonate (150 gr. to the pint of distilled water) are indicated. Quinine should be withheld but if parasites are found to be present during the course of the disease full doses of atehrin should be given and a course of atehrin should be given as a routine during convalescence. If possible the patient should leave the endemic area as soon as he is fit to travel and should not return. One attack of blackwater fever pre-disposes to others which tend to increase in severity.

LEISHMANIASIS

Leishmaniasis occurs in two forms, one generalised, the other localised. Both are caused by various morphologically indistinguishable species of *Leishmania*, minute protozoa closely related to the Trypanosomes which are almost certainly transmitted by *Phlebotomus* ("sandflies").

GENERALISED LEISHMANIASIS (KALA AZAR)

Kala Azar is a chronic febrile disease caused by *Leishmania donovani*. It occurs most commonly in India and China, but also in Africa, South Eastern Europe and South America. On the Mediterranean littoral infants and young children are especially affected and the disease is called Potos or Infantile Kala Azar, while the causative organism is referred to as *L.*

infantum In this area dogs are frequently infected and act as reservoirs of infection

Signs and Symptoms—The onset may be sudden or insidious. There is chronic fever which typically shows two peaks in twenty four hours with long periodical apyrexial intervals. The spleen is enormously enlarged and the liver to a lesser degree, causing a great increase in the size of the abdomen in striking contrast to the wasting of the chest and limbs. Marked leucopenia accompanies a progressive anaemia with normal colour index, and hæmorrhages may occur. In Europeans the skin develops an earthy tint and may show areas of dusky pigmentation. The patient generally feels surprisingly well and has a clean tongue and a good appetite although his temperature may be appreciably raised. Sometimes depigmented patches occur on the skin and are later replaced by nodules (post kala azar dermal leishmanoid) which may closely resemble leprosy. After many months or years the untreated patient dies of exhaustion or intercurrent disease to which the leucopenia renders him particularly liable.

Laboratory diagnosis rests on the discovery of *Leishmania* in blood smears (which will show normal leucocytes and thus exclude a leukaemia) or in smears made from pulp obtained by splenic puncture. Sternal or tibial puncture may also be employed. In Kala Azar one drop of commercial formalin added to 1 c.c. of the patient's serum causes it to set into a firm opaque jelly within a few minutes. This so called 'alkaloid test' is however, no substitute for microscopical diagnosis.

Pathology—The essential fact in the pathology of Kala Azar is the parasitisation and proliferation of the cells of the reticulo-endothelial system.

Treatment—Antimony is a specific remedy. Tartar emetic (sodium antimony tartrate) in doses not exceeding 2 gr. may be given intravenously in 2 per cent. solution on alternate days for six to eight weeks but one of the pentavalent preparations is now generally used. Of these, neostibosan and urea stibamine are probably the most successful. These preparations have the advantage of being suitable for either intravenous or intramuscular injection. A total of 3 to 5 grm. in ten to fifteen doses given two or three times a week is usually sufficient to effect a cure. Diamidino stilbene has recently been used with promising results.

LOCALISED LEISHMANIASIS

1. *Cutaneous Leishmaniasis* (Oriental Sore) occurs in Asia, Africa, South Eastern Europe, South America and Australia.

but is most common in limited areas of India, Iraq, Syria, Palestine, Iran, Arabia and North Africa, where it has many local synonyms. It is noteworthy that oriental sore and Kala Azar rarely occur in the same geographical area. It is a localised, specific, ulcerating granuloma of the skin of exposed parts of the body and is caused by *L. tropica*. The sore commences as a minute, itching papule single or multiple. Later it becomes indurated and covered by a scaly crust which is frequently scratched off, uncovering a shallow indolent ulcer an inch or more in diameter. After three to twelve months slow healing occurs, leaving a depressed scar. A considerable degree of immunity results. *L. tropica* can be found in serum withdrawn in a capillary pipette from beneath the edge of the sore. A course of one of the pentavalent antimony compounds is the best treatment when the sores are multiple. Locally, when secondary infection has been dealt with, eugenol or 2 per cent antimony ointment may be applied, or emetine or berberine may be injected into the edge of the sore. A x-ray ionisation or carbon dioxide snow may be used. Recently good results have been claimed for the local application of sulphapyridine.

2. Nasopharyngeal Leishmaniasis (Espundia) occurs only in limited areas of South America and is due to infection with *L. braziliensis*. It causes infiltrating sores of the mucous membrane of the mouth and nose, which though they may heal temporarily eventually fungate and cause great local destruction. Death from exhaustion or intercurrent disease follows months or years of great suffering, but the condition is amenable to treatment by antimony.

TRYPANOSOMIASIS

African trypanosomiasis (the final stage of which is often called sleeping sickness) is confined to tropical Africa, in certain districts of which it is widespread and very fatal, depopulating large areas and causing great desolation.

It is caused by trypanosomes—small flagellate protozoa which infect the blood and are transmitted from man to man by the bite of tsetse flies. Many wild animals are similarly infected and act as a reservoir of the disease.

Two main types of the disease occur and are caused by trypanosomes of different but morphologically indistinguishable species transmitted by different species of tsetse flies.

The trypanosomiasis of the Belgian Congo, the Cameroons

and the Gold Coast is caused by *Trypanosoma gambiense* and is transmitted by *Glossina palpalis* and *Glossina tachinoides*. The disease runs a relatively mild course. The trypanosomiasis of Rhodesia and Mozambique is caused by *T. rhodesiense* and is transmitted by *G. morsitans*. In Tanganyika both forms occur.

Symptoms—About six weeks after being bitten by an infected tsetse fly the patient starts to have an irregular intermittent fever with various erythematous eruptions and localised œdema and hyperæsthesia. Later there is a general enlargement of the lymphatic glands especially in the neck and of the liver and spleen and respiration and pulse rate are quickened and there is thoracic pain. These symptoms may continue for months or even years during which trypanosomes can be demonstrated in blood smears. Recovery may take place but more often the cerebrospinal system is invaded and trypanosomes are present in the brain and cerebrospinal fluid. Although various psychical and even maniacal symptoms may occur at first the patient gradually becomes increasingly lethargic and somnolent finally lapsing into coma and dying from exhaustion or intercurrent disease.

Diagnosis rests on the demonstration of trypanosomes in the blood, lymph glands or cerebrospinal fluid.

Treatment—Germanin (Bayer 205) Tourneville 309 or the British equivalents Antrypol and Suramin are the most effective drugs in the early stages. All are complex preparations of urea. Three 1 gm. doses are given intravenously on alternate days and seven more similar doses at weekly intervals. In the later stages Tryparsamide appears to be the drug of choice. A combination of these drugs may be used. Recently Synthalin, a guanidine compound, has been recommended and it seems that this may prove of value in cases resistant to arsenic.

Control and prevention of trypanosomiasis is a huge problem. It involves the study of the habits and breeding places of the various species of tsetse flies with a view to their destruction and of the role of animals as reservoirs of infection. Personal prophylaxis is mainly a matter of avoiding the bites of the flies but there is some evidence that injections of Germanin (or its equivalents) reduce the severity of the disease if it is subsequently acquired though they do not prevent infection.

American Trypanosomiasis or Chagas' disease is restricted to limited areas of South America. It is caused by *Trypanosoma cruzi* which is transmitted by the flying bug *Triatoma*. Armadillos form a reservoir of infection. It causes acute conjunctivitis, facial œdema and adenitis, fever and enlarge

ment of the thyroid gland liver and spleen. Chronic nervous, myxoedematous and cardiac types are described.

No effective treatment is known.

DYSENTERY

Dysentery means the passage of blood and mucus from the bowel with accompanying colic or tenesmus. The word is, however, generally reserved for two specific diseases namely, bacillary dysentery usually due to Shiga's *Flexner's* or Sonne's bacillus and amoebic dysentery due to the protozoon *Entamoeba histolytica*. (Dysentery due to Sonne's bacillus is described on p. 256)

Bacillary and amoebic dysentery are by no means purely tropical diseases, but tend to occur more commonly in the tropics because it is there that is found the general disregard of sanitation and hygiene that is necessary for their spread. In temperate climates dysentery is practically limited to institutional outbreaks.

Control of Dysentery—The mode of spread and, therefore, the control of dysentery are the same whether it is bacillary or amoebic. The causative organism is generally transferred from feces to food by the house fly, though contamination of food and water by dust and by "carriers" may also be important. The disease will therefore occur where there is no efficient system for the disposal of feces or for its protection from flies pending disposal, where flies and dust are particularly troublesome and food is not adequately protected from them, and where drinking water is not sterilised or obtained from a reliable source. Control involves the fly proofing of latrines the prevention of promiscuous defecation and the disposal of feces (in the absence of a water carriage system) by incineration or sterilisation. There should be dealt with by abolition of breeding places the incineration of manure and kitchen refuse, and by the use of traps, poisons and fly papers. Food must be protected by thorough fly proofing of all larders kitchens and dining rooms and by the use of gauze covers. Food and vegetables that are eaten uncooked should be peeled or well washed in a weak solution of potassium permanganate. Drinking water, unless its source is above suspicion, must be boiled or otherwise sterilised. Cooks and waiters should be periodically examined to ensure that they are not "carriers," and their personal hygiene should be supervised. Because of the difficulty of applying these measures under active service

conditions dysentery has always been the scourge of armies in times of war and has often been responsible for more casualties than have been inflicted by the enemy

The spread of the disease by direct contagion is limited to communities where the most elementary sanitary principles are disregarded as in native bazaars and lunatic asylums. Active immunisation against bacillary dysentery by vaccines has not proved successful in the past because of their toxicity but the results of limited trials of various recently produced detoxicated vaccines have been promising. A short lived passive immunity may be bestowed by the administration of 10 000 units of antitoxin in the case of Shiga infections

BACILLARY DYSENTERY

Bacillary dysentery is an acute epidemic disease caused by the invasion of the mucosa of the intestine by *B. dysenteriae* Shiga or by one of the several strains of *B. dysenteriae* Flexner. Shiga infections are usually far more severe than Flexner on account of the greater degree of toxæmia caused by the former organism.

Pathology—Generally speaking dysentery bacilli do not occur outside the intestinal canal and do not invade the submucosa. The typical lesions occur in the distal part of the large intestine but may extend to include the lower third of the ileum and are due to the action of the toxins produced by the bacilli. In acute dysentery there is at first a general hyperæmia of the mucous membrane and hypersecretion of mucus. Later there are submucous hæmorrhages and diffuse superficial coagulation necrosis with shallow snail track ulceration of the transverse folds of the mucosa forming islands of granulation tissue serpiginous in outline surrounded by hyperæmic mucous membrane. In severe cases the necrosis may proceed to actual gangrene so that the mucous membrane is completely destroyed and the gut is contracted into a rigid tube containing green or black sloughs. Other organs show the signs of acute toxæmia. A mucous colitis often results and a fibrotic stenosed large intestine may follow. The liability to stenosis will be appreciated if it is remembered that in bacillary dysentery the ulceration spreads round the gut rather than along it.

Signs and Symptoms—Mild catarrhal ordinary ulcerative fulminating choleraic and relapsing types have been described.

After a short incubation period of something less than a

week, sudden abdominal pain and an urgent call to stool usher in the disease. Thereafter colic increases, the temperature rises and the frequent motions become less fecal and contain an increasing proportion of mucus and bright red blood resembling red currant jelly. Tenesmus inflammation of the anus and even prolapse of the bowel ensue as the motions increase up to thirty, forty or even more in twenty four hours, and the colon can be felt if the abdomen is not too tender to permit palpation.

In fulminating cases the stools may resemble "meat washings" and may even become serous, while in the most severe forms (usually Shiga infections) toxæmia may prove fatal before the number and constitution of the stools has caused alarm. High fever, the passage of offensive sloughs, delirium and luecem are grave signs.

A chronic form of the disease is not uncommon after recovery from the acute attack and may occur occasionally without an acute stage, and is then marked by several daily stools containing blood and mucus, wasting, dyspepsia and neurasthenia. The descending colon is often thickened and palpable.

Synovitis and arthritis with sterile effusion, especially of the knees and ankles may occur during the acute stage of the disease, or more usually during convalescence. Conjunctivitis, iritis, proctitis and peripheral neuritis may also occur as complications and as they are the result of toxæmia, are more common in Shiga infections.

Diagnosis.—Colitis, malignant disease, diverticulitis, polyposis and especially malarial dysentery, must be borne in mind and excluded, but as the initial treatment is the same in both bacillary and amoebic dysentery it can and must be commenced at once without waiting for a certain diagnosis. In acute bacillary dysentery the stools consist almost entirely of bright red blood and viscid mucus and are practically odourless. Microscopically the mucus contains numerous polymorphonuclear leucocytes and red blood cells a number of large macrophage epithelial cells (which are liable to be mistaken for *Entamoeba histolytica*) and scanty non motile bacilli. There is very little fecal material.

Although a tentative diagnosis can often be made from the cellular characteristics of the exudate, final proof must rest on culture of the causative organism. It is essential that the clinician should realise the importance of submitting a stool to the laboratory as early as possible in the disease and as soon as possible after it is passed.

Treatment.—Certain general measures must be adopted

from the outset in all cases of dysentery without waiting for a definite diagnosis. These include strict confinement to bed with the use of a bedpan, starvation diet and, unless the patient is collapsed, purgation.

An initial dose of an ounce of castor oil or 2 drachms of sodium sulphate should be followed by sodium sulphate in drachm doses hourly on the first day and two hourly on the second. Salines should be continued in decreasing amount for another few days until the stools are faeculent again. If diarrhoea persists full doses of bismuth carbonate or kaolin may be given. Although it is a mistake to persist with salines for too long it is essential to get rid of the invading organisms and their toxins before attempting to control the diarrhoea with drugs whose action is largely that of a cork. Chlorodyne in doses of 20 minims three times a day is useful for the relief of pain. Opium and morphia may be given in severe cases.

Colonic lavage is usually not indicated in the acute stage, but a hot (100° to 102° F) rectal wash out or an enema of starch and opium (30 minims of tincture of opium to 2 or 3 oz of thin starch) may be comforting and may be preceded by the introduction of a cocaine and morphia suppository.

Antitoxic serum should be given as early as possible in the disease before the effects of the toxins become operative. It is of little use after the third or fourth day. From 20,000 to 50,000 units of the polyvalent serum should be given intramuscularly according to the severity of the case, and the dose may be repeated daily for two or three days. In very severe cases it may be given intravenously in 2 pints of saline or 5 per cent glucose.

Where Shiga's bacillus is isolated the specific serum should be used. The risk of anaphylaxis should be guarded against, and it is advisable to give 30 gr of calcium lactate on the day the serum is administered and on the three following days.

Bacteriophage has not fulfilled its early promise.

Drugs of the sulphonamide group are effective in cases of Flexner dysentery but have yet to prove their value in the more severe Shiga infections. Sulphamylguanidine, only about one third of which is absorbed when taken by the mouth, is the most promising drug. An initial dose of 0.1 gm per kgm of bodyweight may be followed by maintenance doses of 0.05 gm per kgm four hourly, until the stools are reduced to about four per day. Thereafter 0.1 gm per kgm should be given eight hourly for a further three days. The drug should

not be continued for longer than fourteen days in all and the white cell count should be watched

Diet must be increased very gradually, and not until there is definite clinical improvement otherwise relapse is likely to result and the disease may become chronic For the first two or three days only water, barley water imperial drink and tea should be allowed in small quantities at frequent intervals Thereafter arrowroot Beager's food chicken tea beef tea and jellies should be added cautiously so that egg slips and milk puddings are being taken by the eighth day and a fish diet by the tenth Alcohol must be strictly forbidden during the disease and for a month afterwards

In chronic cases high colonic lavage on alternate days should be combined with a light diet and a morning saline To remove mucus an initial enema of a pint of warm water containing 60 gr of sodium bicarbonate should be given Half an hour later the lavage is given slowly by gravity through a rubber urethral catheter A pint and a half of warm isotonic saline should be used and should be retained for ten to fifteen minutes during which the patient should assume first the left lateral then the genupectoral and lastly the right lateral position Various medicated retention enemata have been recommended Autogenous vaccines are well worth a trial and recently a diet of apples has been advocated There is accumulating evidence that in colitis and chronic dysenteric conditions there is a general avitaminosis and the administration of vitamins is therefore well worth a trial

Joint effusions should be aspirated and counter irritant dressings applied

It is most important that the stools should be examined macroscopically and microscopically throughout the disease in order that the condition of the colon may be assessed Everything passed from the bowel must be scrupulously disinfected until repeated cultures prove negative

AMOEBIĆ DYSENTERY

Amoebic dysentery is a disease of insidious onset and chronic course caused by infection of the bowel wall by *Entamoeba histolytica* Secondary or metastatic amoebiasis (principally of the liver) may follow the penetration of the amoeba into the tissues and their spread by the blood stream

Ætiology—*Entamoeba histolytica* in its vegetative or active form is an amoeba about two or three times the size of a poly-

morphonuclear leucocyte. It possesses the power of amœboid movement of throwing out pseudopodia which engulf the red blood cells leucocytes and other debris on which it lives and of secreting a histolysin which enables it to penetrate the tissues. In this form it is extremely delicate and would soon perish when passed from the bowel. In unfavourable conditions it therefore encysts and the round quadrinucleate cyst thus formed possesses sufficient resistance to desiccation and extremes of temperature to allow it to be transferred by the agency of carriers flies water uncooked food and possibly dust to be ingested by other persons in whose intestine it excysts and liberates the active pathogenic amœba.

There are other amœbæ and their cysts (notably *E. coli*) which occur in the intestine and faeces which are liable to be mistaken for *E. histolytica* but they are none of them pathogenic.

Pathology—The amœbæ dissolve their way down through the mucosa submucosa and muscular layer where they produce small submucous abscesses so that the mucous membrane becomes studded with minute yellow pustules. These little abscesses burst and produce ulcers which increase in size and become funnel shaped the edges being regular and the bases covered with sloughs. These ulcers may coalesce and tend to spread in the long axis of the gut. They are separated by areas of normal mucous membrane. Deeper penetration of the amœbæ may result in perforation peritonitis and adhesions between adjacent coils of gut or between gut and liver or spleen while erosion of blood vessels may cause hemorrhages and thromboses and the spread of amœbæ to distant parts of the body with resultant metastases. Amœbic ulceration is commonest in the cæcum hepatic flexure and sigmoid colon the lower ileum being only rarely affected. There is general compensatory thickening of the gut. Ulceration may become chronic and be followed by polyposis and carcinoma.

Signs and Symptoms—The incubation period is several weeks. The onset is insidious and often there is no more than colic and perhaps mild diarrhoea indeed death may result from perforative peritonitis or metastatic amœbiasis may occur without there having been any dysenteric symptoms. Tenesmus is not marked unless the rectum is affected and abdominal tenderness is localised and may simulate appendicitis. The stools are rarely numerous and consist of faeces flecked with mucus and streaked with blood. They are offensive and are said to resemble anchovy sauce. There is seldom any fever or toxæmia. While gangrenous fulminating cases do

occur, the disease typically runs a chronic course which often does not keep the patient to his bed or even away from his work indeed in the most insidious cases the symptoms may be so slight that the suspicion of malingering may arise, the patient being listless and tired and showing nothing clinically beyond a mild tachycardia and an occasional extra systole. It may fairly be said that the seriousness of amœbic dysentery lies not in the dysentery but in the penetrative power of the amœbe and the dangers resulting from it.

Diagnosis—Microscopic examination of the stools and the finding of *Entamoeba histolytica* or its cysts can alone supply a conclusive diagnosis. For this purpose *warm freshly passed stools* should be repeatedly examined. Often the detection of the amœbæ is facilitated by a saline purge, so there is every reason for proceeding with the normal initial treatment of dysentery.

Entamoeba coli is not infrequently present in the stools in cases of bacillary dysentery. It is therefore imperative that the pathologist should be competent to distinguish with certainty between these two amœbæ and their cysts or wrong diagnosis and treatment may well have fatal results. The points of differentiation are beyond the scope of this book and can be learned only by the study of fresh specimens, but it may be said briefly that *E. histolytica* is generally smaller and more active than *E. coli*, and while the former often contains ingested red blood cells the latter never does. The cysts also tend to be smaller in the case of *E. histolytica* and typically contain four nuclei in that species whereas the cysts of *E. coli* contain more than four nuclei. Microscopical examination of the stools will also reveal that the red cells tend to show rouleaux formation while comparatively few pus cells and macrophages are seen but there are numerous motile bacilli and often a number of Charcot Leyden crystals.

Sigmoidoscopic examination is often of great help in enabling the condition of the bowel to be studied and amœbæ may often be found in scrapings from the ulcers when it has not been possible to find them in the stools. The comparative painlessness of sigmoidoscopy in amœbic infections is in itself a point of some diagnostic importance.

Amœbic dysentery is usually accompanied by a moderate leucocytosis.

Treatment—There are several drugs that are specific against *E. histolytica* and all of them possess toxic properties. It is therefore wrong to administer any of them unless the diagnosis has been established and if laboratory facilities exist their

use as diagnostic agents, as quinine is used to diagnose malaria is to be avoided. Of these drugs emetine, an alkaloid of ipecacuanha, is the most lethal to the amœbæ and the most toxic to the patient.

In acute cases the treatment should follow the general lines recommended for bacillary dysentery. Serum should not, of course, be given. A single daily saline is usually sufficient and the diet may be rather more generous. Emetine hydrochloride 1 gr in 1 c c of distilled water should be given hypodermically on each of the first ten days. It should be remembered that emetine is a dangerous remedy for a serious disease and that it may affect the heart and occasionally the nervous system and the patient must, therefore, be *confined to bed* and carefully watched and nursed.

After this ten day treatment the patient should have a few days rest from active treatment and should then be given a course of emetine bismuthous iodide (E.B.I.). Owing to its tendency to cause nausea and vomiting E.B.I. should be given last thing in the evening when the patient is going to remain undisturbed. Ten to fifteen minims of chlorodyne or tinct opii given half an hour previously may check excessive vomiting. E.B.I. should be administered in gelatine capsules in a dosage of 1 gr on the first day, 2 gr on the second day and 3 gr on each of the subsequent ten days. During this course colonic lavage should be given daily with a pint and a half of warm water containing 90 gr of sodium bicarbonate and should be followed by an enema of 6 to 8 oz of 2½ per cent chinofon* (B.P.) *which should be retained for eight to ten hours*. The rationale of this treatment is that while emetine acts on amœbæ in the tissues, E.B.I. and chinofon act on those in the lumen of the bowel.

In resistant or relapsing cases trial should be made of stovarsol or carbasone in doses of 4 gr twice daily for ten days. Chinofon pills and Kurchi bark and its derivatives are also recommended.

Diet should be light and milk is not contraindicated. Alcohol must not be allowed.

Scrupulous care must be taken to disinfect the stools until repeated examinations fail to reveal amœbæ or cysts. For some time after apparent cure the stools should be periodically examined to make sure that the patient does not become a "carrier" or cyst passer who will be a danger to the community and liable to develop any of the various amœbic metastases.

Because the diagnosis between bacillary and amœbic

* Yatren Quinoxyl, Quinosulphan,

dysentery is of such supreme importance and because confusion has in the past so often led to unnecessary loss of life, the main points of distinction are summarised below :—

Bacillary Dysentery

An acute, epidemic febrile disease of short duration and sudden onset occurring most commonly in dry climates and having an incubation period of not more than a week.

The tongue is clean, toxæmia is marked, and tenesmus common. There is general abdominal tenderness.

The stools are scanty, numerous, odourless, alkaline, and consist almost entirely of blood and mucus—"red currant jelly." Microscopically red blood cells and polymorphonuclears are numerous, macrophage cells are plentiful, and organisms scanty and consist mainly of non motile bacilli.

Leucocytosis is unusual.

Ulcers, when present, are shallow, with serpiginous outline, the bases consisting of granulation tissue. They tend to occur on the free edges of the transverse folds of the gut. The whole mucous membrane is hyperæmic or necrosed.

The only important complications are arthritis and intus. Chronic colitis and stenosis may follow.

Amœbic Dysentery

A sub-acute or chronic, endemic, afebrile disease of long duration and insidious onset occurring most commonly in humid climates and having an incubation period of three to twelve weeks.

The tongue is dirty, toxæmia is not marked, and tenesmus is unusual. There is localised abdominal tenderness.

The stools are large, not very numerous, offensive, acid, and consist of fecal material streaked with blood and mucus—"anchovy sauce." Microscopically red blood cells occur in clumps, polymorphonuclears are damaged, macrophages are not common. Charcot Leyden crystals are often seen and there are numerous motile bacilli.

Leucocytosis is the rule.

Ulcers are deep and funnel shaped with a regular outline, the bases consisting of sloughs. They occur in the long axis of the gut. Intervening mucous membrane is normal.

Apart from immediate dangers such as perforation, peritonitis, and hæmorrhages, the only common complication is hepatitis and liver abscess.

METASTATIC AMŒBIASIS

During the course of amœbic infection of the intestine, invasion of the skin around the anus may occur, and the same thing may happen round a colostomy or appendicectomy wound resulting in a spreading ulceration. Such conditions respond readily to emetine. The true metastatic lesions resulting from the primary infection of the gut are, however, blood borne. The erosion of a small vessel in the gut wall results in the amœbæ being carried up the mesenteric and portal veins to the liver which is by far the commonest site of such lesions. Amœbiasis of the brain, spleen, and lung may occur.

Amœbic Hepatitis and Liver Abscess

The great majority of untreated cases of metastatic amœbiasis take the form of an abscess, more often single than

multiple in the right lobe of the liver though early diagnosis and treatment may arrest the condition in the stage of hepatitis which precedes it. The disease is rare in natives and in European women and children.

It should be remembered that although there is always a primary infection of the gut this may have caused such mild symptoms that no history of dysentery is obtainable and the absence of such history must never cause the possibility of hepatic amœbiasis to be overlooked in any case of debility or chronic ill health in a person who has lived in the tropics. The condition may arise as long as twenty years after the primary infection.

Symptoms Signs and Diagnosis—The existence of malaise irritability loss of weight and appetite coated tongue and irregular action of the bowels in one who has lived in a country where amœbiasis is endemic should never fail to arouse suspicion. If to these symptoms be added a muddy complexion evening pyrexia and night sweats heaviness or pain in the right hypochondrium and a dry irritative cough the diagnosis can hardly be in doubt. Pain may be referred to the right shoulder or to the appendicular region and physical examination may show enlargement of the liver and signs of pleural involvement or right basal pneumonia. Diminution of movement of the diaphragm and deformity of its right dome may be seen in radiographs and when accompanied by a moderate leucocytosis with a relatively normal lymphocyte polymorphonuclear ratio it is presumptive evidence of the existence of a fully developed abscess and may be confirmed by aspiration. Amœbæ though present in the growing edge of the abscess are not often found in the pus.

Sufficient thought must be given to differential diagnosis to prevent the possibility of overlooking hepatic enlargement due to malaria hydatid cyst gumma malignant disease and kala azar but exploratory puncture is generally a justifiable confirmatory measure. In acute cases with congestion it is often advisable to postpone this step until a course of emetin has failed to reduce the temperature and the leucocytosis. Aspiration should be performed under local or general anaesthesia with a wide bore cannula and ample suction the site of election being in the absence of localising signs a point in the eighth or ninth intercostal space in the anterior axillary line. The needle should be introduced inwards and slightly upwards and backwards for a distance of three to three and a half inches. Several punctures should be made before abandoning the attempt. The stools should always be carefully and repeatedly examined for amœbic cysts.

If untreated an amœbic abscess may burst into the lung pleura pericardium or peritoneum or may become secondarily infected. Adequate treatment reduces the mortality from about 70 per cent to practically nil.

Treatment—In amœbic hepatitis a course of ten daily hypodermic injections of 1 gr of emetine should be given during which the patient must be kept in bed on a low diet. If cysts are present in the stools this should be followed by a course of emetine luminal iodide by the mouth and chinoson enemata as in amœbic dysentery.

Even when an abscess has formed emetine alone may often effect a cure but as a considerable amount of pus may be present (as much as 6 pints has been recorded) aspiration may be necessary in association with a course of emetine. After aspiration 1 or 2 gr of emetine in 10 c.c. of sterile distilled water should be injected into the abscess cavity. Aspiration may have to be repeated if the cavity fills up again. Strict attention to asepsis must be observed or secondary infection will inevitably follow. Surgical drainage is to be avoided and open operation is rarely justified.

CHOLERA

Ætiology and Epidemiology—The disease is caused by the comma shaped *Vibrio cholerae* which infects the mucosa of the small intestine and produces a potent endotoxin. The vibrio is usually ingested in water contaminated by persons suffering from the disease or carrying the organism during convalescence. Healthy carriers are rare. Less commonly the disease is contracted by eating food (especially raw fruit or vegetables) which in turn has been contaminated by water a carrier or flies. India is the endemic focus from which the disease spreads along the routes taken by traders and pilgrims to all parts of Asia. It is now well over half a century since the disease occurred in the British Isles or America. Although a certain minimum atmospheric humidity is necessary the spread of an epidemic depends chiefly on the existence of insanitary conditions and it is to the eradication of these conditions that Western Europe owes its comparatively new found freedom from the disease.

Pathology—The multiplication of the vibrio in the small intestine and the liberation of toxins cause a hyperemia and later a superficial necrosis of the mucous membrane and the loss of large quantities of fluid from the bowel. Severe

dehydration ensues involving hæmo concentration lowering blood pressure muscular cramps suppression of urine and uræmia. The loss of salts from the blood causes acidosis. These effects are aggravated by the action of the absorbed toxins which themselves cause a fall in blood pressure and damage to the secreting tubules of the kidneys.

Signs and Symptoms—After an incubation period which varies from a few hours to about a week and with or without premonitory diarrhœa the disease sets in with the passage of profuse and frequent motions often unaccompanied by colic. The motions at first faecal rapidly lose their colour and assume the typical rice water appearance—watery fluid containing flakes of necrosed intestinal epithelium. In this the *stage of evacuation* enormous quantities of this fluid are lost both by diarrhœa and vomiting. As the fluid contains the vibrio the attendants run a considerable risk of being infected. Dehydration produces intense thirst the urine diminishes in amount the blood pressure falls the pulse becomes small and thready the temperature drops and the patient passes into the *algid stage*. The eyes are sunken the intra ocular tension is reduced and the eyelids pearly white. The skin becomes clammy and wrinkled (washer woman's fingers) and of an earthy hue often with cyanosis at the extremities. The surface temperature and the blood pressure drop still further and the pulse may be barely perceptible. Severe and agonising cramps in the calves occur and the patient although fully conscious cannot speak above a husky whisper. The urine may be completely suppressed. If a vein be opened only a small bead of dark tar blood may exude the specific gravity of which may exceed 1.070 as compared with the normal 1.038. It is in this stage often within twenty four to thirty six hours of the onset of the disease that death is most likely to occur either in convulsion or after sudden collapse.

Recovery is heralded by a general remission of symptoms which constitutes the *stage of reaction*. The motions decrease in number and volume and bile reappears in them. The temperature rises and may become hyperpyrexial the pulse improves urine is secreted and the skin regains its normal appearance. Recovery is usually surprisingly rapid having regard to the seriousness of the disease but in this stage the patient is by no means out of danger and death may occur from pneumonia hyperpyrexia or uræmia. Convalescence is apt to be complicated by rickets toxic nephritis chronic enterocolitis furunculosis insomnia and mental depression.

In addition to the classical cholera described above an

bulatory cases may occur (especially late in an epidemic), and may suffer from little more than malaise and diarrhoea. On the other hand, severe, fulminating cases are sometimes seen in which death from toxæmia occurs before diarrhoea or vomiting have made their appearance the so called "cholera sicca."

Mortality in treated cases varies from 20 to 50 per cent.

Diagnosis—This rests finally on the demonstration of *Vibrio cholerae* in the evacuations by cultural and biochemical methods. Once an epidemic is well established diagnosis presents no difficulty, but in the earlier or sporadic cases bacillary dysentery, malignant malaria, and food poisoning must be excluded. In malaria the temperature is high and in food poisoning the vomiting precedes the diarrhoea whereas in cholera it follows it. It should be remembered that dysentery, enteric fever, or malaria may co exist with cholera.

Treatment—This aims to replace fluid loss, to neutralise acidosis, and to destroy toxins.

Throughout the disease the temperature must be carefully watched and the urine must be measured. The patient must be kept warm and should wear a "cholera belt." Food should be withheld altogether until the choleraic diarrhoea ceases but unlimited boiled water "pinked" with potassium permanganate (1 gr. to the pint) should be allowed, and potassium permanganate in pill form should be administered until the stools become and remain green. As much as 50 gr. may be given in the twenty four hours to oxidise the toxins. Kaolin in a strength of 1 to 1 in water may be swallowed in large quantities and acts by adsorbing the toxins. To check purging and vomiting it is wise to give from the outset eight or nine half hourly doses of essential oils—clove, cajuput, and juniper, 5 minims of each, with 30 minims of spt. ether and 15 minims of acid sulph. arom. Bacteriophage and antitoxic serum, although somewhat uncertain in their action are worth a trial, but they must be given immediately symptoms appear.

The essential treatment in cholera, however, is the replacement of fluid and salts. This should be effected by the slow intravenous infusion of two solutions of saline, one alkaline, the other hypertonic. The alkaline solution consists of 90 gr. of sodium chloride and 160 gr. of sodium bicarbonate in a pint of sterile distilled water. The hypertonic solution consists of 120 gr. of sodium chloride 6 gr. of potassium chloride, and 4 gr. of calcium chloride to the pint. One pint of the alkaline solution is followed by as many pints of the hypertonic solution as are indicated by the degree of dehydration. As a general rule a pint is required for every unit by which the specific gravity

of the blood exceeds 1 060 up to a maximum of 6 pints. Thus a blood specific gravity of 1 063 calls for the infusion of 3 pints one of alkaline and two of hypertonic saline indicates that about half the fluid of the body has been lost and corresponds to a systolic blood pressure of about 70 mm Hg. Where no facilities exist for such estimations or for preparing these special solutions 3 or 4 pints of normal saline should be given. Infusion may need to be repeated if the blood pressure remains low or collapse still threaten. If there is anuria a pint of normal saline should be given by the rectum every two hours and fomentations should be applied over the loins.

The hypodermic injection of drugs is to be avoided in the algid stage as they are liable to have a dangerous cumulative effect when the circulation improves during the stage of reaction but pituitrin digitalin atropin or adrenaline may be necessary to combat severe collapse or anuria. Cramps may be relieved by massage warmth or short chloroform inhalations.

In the stage of reaction bismuth salicylate in 15 gr doses may control continued purging. Convalescence must not be hurried and diet must be increased with the greatest care.

Prophylaxis—*Personal*—Inoculation with cholera vaccine gives a reasonable degree of protection for a few months. During cholera epidemics the addition of 30 minims of diluted hydrochloric acid or 15 gr of sodium bisulphate to every pint of drinking water is a wise precaution. All water used for drinking or in the preparation of food should be boiled. Salads and fruit should be avoided altogether or soaked for two hours in 1/8000 potassium permanganate. Melons and cucumbers are particularly dangerous. A daily dose of essential oils is a useful preventive. Every effort should be made to avoid any thing likely to upset the digestive tract not excluding purgatives.

General—Cholera patients must be isolated for six weeks or until the stools are free from the vibrio and during this time all dejecta as well as all soiled clothes or bed linen must be thoroughly disinfected. Carriers should be sought out and contacts isolated for ten days.

Water supplies must be carefully supervised and some sure method of sterilisation practised. Access of flies to infected material and to food must be prevented.

SPRUE

Sprue is a chronic disease of variable symptomatology but classically there is dyspepsia abdominal distension and

diarrhea, glossitis and anemia. It occurs in those who live or have lived in certain tropical or subtropical areas, especially India and Ceylon, China, the East and West Indies, and Central America. It bears a close relationship to celiac disease and idiopathic steatorrhea (which has been called "non tropical sprue").

Sprue is probably a deficiency disease the essential fact in the etiology being impairment of absorption from the small intestine consequent on atrophy of the mucous membrane. The cause of this atrophy is not known and is the subject of much speculation. The impairment of absorption embraces fats, glucose, calcium, iron, vitamins, and the extrinsic anti-anemic factor. A consideration of the results of the failure to absorb these substances will explain the symptoms.

Symptoms are insidious in onset and follow an uncertain but prolonged incubation period. Only in fully developed cases are all the symptoms likely to be seen and moreover, their severity varies greatly. Irritability, stultent dyspepsia, and morning diarrhea are among the earliest manifestations. The stools are large, pale, gaseous and foul smelling and may contain twice the normal proportion of fat, which is, however, completely split. Soreness of the tongue with thinning of the mucous membrane and atrophy of the filiform papillae is a common and distressing feature. Meteorism, cramps, and tetany may occur, and a megalocytic anemia may develop which is indistinguishable from true pernicious anemia. There may be achlorhydria but rarely a complete achylia. In late cases peripheral neuritis and signs of subacute combined degeneration of the cord may appear, and in untreated cases death follows increasing debility and emaciation.

Treatment—There is no specific remedy. The object of treatment must be to give complete bodily rest and to administer small frequent feeds of only the most easily absorbed substances. Fats and fermentable carbohydrates must, therefore, be reduced to a minimum. A milk or high protein diet should be adhered to until the condition of the patient and the constitution of the stools indicate definite improvement. Fruit meat juice, and liver may be added gradually, but the diet must be carefully regulated for at least six months after apparent cure. Although vitamin therapy has not yet emerged from the experimental stage it is a logical treatment, and excellent results have been obtained from large doses of the B complex (nicotinic acid and riboflavin). The anemia should be treated with intramuscular injections of liver extract and the administration of iron. In very advanced cases blood transfusion should be tried. Strict

but sympathetic nursing is essential, and the patient should leave the endemic area as soon as possible

YELLOW FEVER

Yellow fever is a severe, acute, specific disease caused by a filterable virus transmitted from man to man by the mosquito *Aedes ægypti*. It is characterised by fever, albuminuria, hæmorrhages, jaundice, and its peculiarly limited geographical distribution. It is a disease that is becoming increasingly important epidemiologically as the endemic foci become the junctions for more transcontinental air traffic.

Ætiology and Epidemiology.—The virus circulates in the blood of cases of yellow fever only during the first three days of the disease. During this period the virus may be taken up by the mosquito which is capable, after an interval of about ten days, of transmitting it to susceptible persons in whom the disease develops after an incubation period rarely exceeding five days. In this way epidemics are liable to occur whenever *aedes* mosquitoes and susceptible persons exist in sufficient numbers. In the meantime however, the disease is kept alive in the form of sporadic and often unrecognised cases among natives. In forest areas of South America and probably also of Africa the disease exists in a "jungle" form in certain animals amongst which it is transmitted by various forest mosquitoes. From this reservoir man may at any time become infected if he happens to be bitten by such an infected forest mosquito. In urban districts the disease does not occur in the absence of *aedes* mosquitoes. These are found all over the tropical and sub tropical world, and yet yellow fever is confined to limited areas in South America and tropical Africa. The spread of the virus to other parts of the world (especially India), where the vector and susceptible populations await it, might well precipitate the most calamitous epidemic the world has ever seen. With the development of rapid air and overland transport by which several thousand miles can be covered within the incubation period, this risk has been greatly increased, and to meet it the strictest quarantine laws have been applied at ports and aerodromes, and elaborate steps have been taken to prevent the virus being exported or imported in man or mosquito.

Control of yellow fever depends on the immunisation of all persons entering an endemic area, the quarantine of all non-immunised persons leaving such areas, the prevention of the

export of mosquitoes in sea land or air transport, the early recognition and screening of cases of the disease and the local elimination of *Aedes* mosquitoes. Since these mosquitoes are domestic in their habits and breeding places their destruction is not difficult and involves attention to tanks, gutters, tins, flower vases and other collections of stagnant water in which they breed.

Inoculation with attenuated pantropic virus should be given to everyone proceeding to an endemic area. Immunity follows within a fortnight and lasts for at least eighteen months. Mosquito nets should always be used.

Pathology.—There is jaundice and evidence of widespread hæmorrhages especially of the stomach and bowel and generalised fatty degeneration of the organs and vessels. The liver is friable and of a "box wood" colour, fatty and hyaline degeneration is marked at the periphery of the lobules and there are diagnostic changes in the nuclei and cytoplasm of the liver cells.

Signs and Symptoms—Onset is sudden and there is often a rigor. For two or three days there is fever with general congestion, frontal headache, vomiting epigastrie and loin pain, and a full rapid pulse. By the third day *albumen appears in the urine in increasing quantities*, the temperature falls, and there is general abatement of symptoms. Convalescence may commence at this stage but more often a stage of reaction ensues in which the urine diminishes and albuminuria increases, hæmorrhages (especially of the stomach and bowel, causing black vomit and mæna) occur and jaundice appears. The pulse tends to be slow in relation to the temperature (Faget's sign). In fatal cases toxæmia increases and death occurs in coma or convulsions. Abortive, ambulant, severe and pernicious types are described. Mortality is about 25 per cent.

Diagnosis can be made with absolute certainty only by animal inoculation. Clinically the increasing albuminuria and falling pulse rate should arouse suspicion. Jaundice and black vomit must not be relied upon as they are usually late features. In spirochætosis icterohæmorrhagica there is a leucocytosis whereas a leucopenia usually accompanies yellow fever. Malaria, blackwater fever, relapsing fever, and dengue may bear a close resemblance. Post mortem diagnosis by the histological appearance of the liver may be of great value in doubtful or sporadic cases. To obviate a mutilating examination, permission for which is often refused, an instrument called a viscerotome has been devised with which a small cube of

liver substance can be removed through a puncture wound about a centimetre in diameter

The mouse protection test has been of supreme value in revealing areas where yellow fever is or has been endemic. The test depends on the fact that the blood of an individual who has had the disease contains immune bodies which protect a mouse when injected with a dose of virus that would otherwise prove fatal. By noting the age above which the members of an isolated community show positive protection tests it is possible to say when an epidemic last occurred. By this means too, the existence of 'jungle' yellow fever has been demonstrated in man and animals in areas where *aedes* mosquitoes do not exist. The test is of no diagnostic value during the attack as it becomes positive only during convalescence.

Treatment is symptomatic, there being no known specific. Careful nursing is essential. Alkaline fluids and glucose both by the mouth and intravenously are given to combat the toxæmia and uræmia. The patient must, of course, be kept under a mosquito net.

DENGUE

Dengue is a specific fever caused by a virus conveyed by the yellow fever mosquito *Aedes ægypti*. The disease, which lasts about a week, is apt to occur throughout the littorals of the Middle East and elsewhere in epidemics or pandemics, and is distinguished by "saddle back" temperature curve, skin rash and severe rheumatic like pains ('break bone fever').

The blood of the patient is infective to the mosquito for a day before the onset of symptoms and for the three following days. The mosquito becomes infective ten to fourteen days after feeding on a dengue patient. The incubation period is five to nine days.

Symptoms—The onset is sudden with fever, congestion of the skin supra and post-orbital pain, suffusion of the conjunctivæ and severe pains in the limbs, loins, and back. After two or three days the temperature falls and the patient feels much better, but after one or two days the fever and pains return and the typical rash appears on the hands, limbs and trunk. It consists of circular, slightly raised reddish brown rubeoloid spots which coalesce to give an appearance "midway between scarlet fever and measles." This terminal fever and eruption rarely last more than twenty-four hours. Bradycardia and leucopenia with relative lymphocytosis are

present throughout the disease, which is often followed by general debility, mental depression, insomnia, furunculosis, and an immunity of uncertain duration. Mortality is nil.

Treatment is symptomatic. The patient must be kept in bed under a mosquito net until the temperature is normal and the rash has subsided. Morphine may be necessary to lessen the pains.

Prevention can be effected only by the use of mosquito nets and the extermination of *aedes* mosquitoes by swatting and spraying and attention to all potential breeding places.

PHLEBOTOMUS ("SANDFLY") FEVER

Sandfly fever is a short specific fever caused by a virus transmitted by a midge of the genus *Phlebotomus*. It occurs in most tropical and sub-tropical countries, but especially on the Mediterranean littoral.

Symptoms—Incubation period is about five days. Fever lasts from three to seven days and is accompanied by congestion, aching pains in the back and legs and severe frontal and post orbital pain with photophobia. A leucopenia gives place to a moderate leucocytosis when the fever subsides.

Treatment is symptomatic. The patient must be kept in bed under a sandfly net, and opium or Dover's powder should be administered. There is no mortality, but convalescence is apt to be prolonged and complicated if the patient tries to fight the disease instead of taking to his bed.

Prevention depends on the avoidance of sandfly bites by the use of nets and suitable clothing after dark, and on the destruction of sandflies and their breeding places.

TYPHUS FEVER

Typhus fever is really a group of fevers all of which are caused by infection with *Rickettsia*, a pleomorphic virus visible with a high power microscope which is present in the blood during the first few days of the disease. Typhus fever can be broadly divided into two main types, the classical epidemic typhus which is transmitted by lice from man to man, to which fact it owes its epidemic character and its cosmopolitan distribution, and endemic typhus primarily a disease of animals which is accidentally transmitted from them to man by ticks, fleas, or mites, and which is localised in various parts

of the world where the animal reservoir of infection, the vector, the climate, and other local peculiarities modify the clinical manifestations of the disease

Epidemic typhus, being louse borne, is a disease associated with war, famine, and destitution, which cause populations to neglect personal cleanliness and to crowd together for warmth or safety, thus providing conditions ideal for the spread of infected lice. It is a disease not of hot climates but of lousy populations, and is most common in China, North Africa, and Eastern and South-Eastern Europe. Cases have occurred recently (1941) in Eire.

The incubation period is from five to fourteen days. Prodromal headache and malaise lasting one or two days usually precede a sudden rise of temperature to 103° or 104° F with congestion, suffused conjunctivæ, and dry, furred tongue. The marked degree of prostration occurring within the first few days of the disease, with a typical vacant expression, are the result of severe toxæmia, and are of diagnostic importance. About the fifth day a rash appears on the abdomen and chest, and spreads to all parts of the body except the face, which is generally spared. The rash is variable in appearance, but typically shows roseolar macules superimposed on subcutaneous petechiæ or mothings. This rash is the result of necrosis of small blood vessels which occurs in the viscera and brain as well as in the skin. With the appearance of the rash there is an exacerbation of symptoms. Headache becomes severe, the tongue is dry and brown, toxæmia increases, and the "typhus state" ensues so that the patient becomes feebly delirious or comatose with albuminuria, retention of urine, and enlargement of the spleen. By the twelfth or fourteenth day the temperature falls by crisis or rapid lysis, and recovery ensues or deepening coma ends in death from heart failure. Complications are not common, but hypostatic pneumonia, venous thrombosis and gangrene may occur, and myocarditis may persist into convalescence. Mortality varies between 5 and 50 per cent in different epidemics, and is greatly increased by debility and advancing age.

Endemic or tropical typhus includes Brill's disease of rats in America, Palestine, Australia, and South Africa, "ship fever" of dogs in several Mediterranean ports and "urban" typhus of rats in Malaya all transmitted to man by fleas. Rocky Mountain spotted fever of North America and "tick" typhus of the Mediterranean, India, Africa, and Brazil, which are transmitted by ticks from squirrels and dogs respectively and Japanese river fever and "scrub" typhus of Malaya, which

are transmitted from rats and mice to man by mites. In these types the symptoms vary considerably and are much milder than in the louse borne disease, and the prognosis is much better. In mite borne typhus there is local necrosis at the site of the bite because the mites remain buried in the skin.

Diagnosis.—In sporadic cases the early prostration and stupor should arouse suspicion, while the rash should confirm it. In epidemics diagnosis is unlikely to be in doubt. The Weil-Felix reaction which becomes positive by about the fifth day and remains so for two months is of great assistance. It depends on the fact that the serum of a typhus patient agglutinates *Bacillus proteus* and that different serological variants of the bacillus are constantly agglutinated in the different types of the disease. The organism although it can frequently be isolated from cases of typhus has not been shown to be any more than a concomitant and causes no specific immune bodies to be formed, though such bodies are produced by inoculation with *B. proteus*. Complement fixation and intradermal tests have been based on this peculiar phenomenon.

Treatment is mainly a matter of careful nursing as no specific drug is known. The hygiene of the mouth is important, and cardiac stimulants are usually necessary. Convalescent serum and the sulphonamides have recently been exhibited with some benefit.

Prevention is purely a matter of keeping the body and the clothes free from lice or of avoiding the bites of fleas, ticks, and mites. Various virus vaccines are obtainable but are at best only a very subsidiary measure.

RELAPSING FEVER

Relapsing fever is an acute, specific, infectious disease characterised by sudden onset, high fever lasting for a few days and sudden deservescence by crisis. During this period there is headache, enlargement of the liver and spleen and leucocytosis and often an erythematous rash which spreads downwards from the neck. Sweating and diarrhoea usually accompany the crisis. Relapses occur, but the duration of both the pyrexial and apyrexial periods varies considerably, the symptoms tending to become milder. Mortality is usually below 5 per cent, but may be much higher. The disease is caused by a spirochaete (*S. recurrentis*), which can be demonstrated in blood smears during the pyrexial periods only, and which is transmitted by lice and by ticks.

Louse borne relapsing fever may occur wherever lice are found and therefore depends more on personal hygiene than on climatic conditions for its existence becoming epidemic in times of war and famine. It is endemic in India, China and Eastern Europe. There are usually two or three relapses each lasting about a week separated by apyrexial periods of the same duration. Prevention is dependent on personal cleanliness and on the destruction of lice and their eggs.

Tick borne relapsing fever occurs in many tropical countries especially Central and West Africa, North West India and Iran, Spain and Morocco, California and Panama. It is a place disease and is most commonly contracted in native rest houses the tick being parasitic only while it feeds thereafter dropping off and living in crevices in walls or in the ground. This form of the disease therefore remains localised, is little affected by season and never becomes epidemic. The febrile periods are shorter than in the louse borne form but relapses are liable to be more numerous. Although the Central and West African form may be very severe the tick borne is on the whole less severe than the louse borne variety. Prevention depends on the avoidance of tick infested sites and of their bites by the use of a mosquito net.

Treatment—A single intravenous injection of 0.45 gm. of neovarsphenamine usually affects a complete cure but it must be given during the pyrexial period and never after the temperature has fallen.

PLAGUE

Plague is an acute specific disease which occurs in epidemic form in tropical countries. The main endemic foci are in India and China. Severe epidemics have occurred in Europe (as for instance the Great Plague of London) but are now practically limited to Asia and South America.

The disease is primarily an epizootic of rats and other rodents and is caused by the *Bacillus pestis*. When rats contract the disease the fleas with which they are infested take up the bacilli from the rats' blood. When the rats die of plague the infected fleas leave their bodies and seek other warm blooded animals on which to feed and thus man becomes infected. Rats therefore form the reservoir of the disease and a sudden heavy mortality among rats should be a warning of an impending human epidemic. In endemic areas and during epidemics rats found dead should never be touched or

approached closely but should be shaved into cresol or oil and subsequently examined in the laboratory for the presence of *B. pestis*.

Signs and Symptoms—The incubation period is from two to five days. There are three clinical types of the disease in all of which there is marked toxæmia with fever, headache and drowsiness.

Bubonic plague is characterised by inflammation and enlargement (buboes) of those lymph glands which lie in the course of the lymphatics draining the site of the flea bites. Inguinal buboes are the rule, while axillary and submaxillary infections are rare. They are exquisitely tender and frequently suppurate. *B. pestis* can be obtained by gland puncture. Mortality varies from 20 to 90 per cent.

Pneumonic plague is transmitted by direct droplet infection from man to man and not by fleas. The physical signs are those of a patchy bronchio pneumonia with blood stained sputum which teems with the bacilli. It is almost invariably fatal within a few days.

Septicæmic plague results from the entrance of large numbers of highly virulent bacilli into the blood and is almost always fatal before the lymph glands have time to enlarge.

An ambulant form (*pestis minor*) is described, which may go unrecognised and consequently be a source of danger to others.

Diagnosis—Early cases may closely resemble typhus fever. Buboes must be differentiated from those of venereal origin and from filarial adenitis. Bacteriological diagnosis is a simple matter in all forms of the disease.

Treatment is mainly symptomatic and is unlikely greatly to affect the course of the disease. If available, anti plague serum in doses of 100 to 250 c.c. should be given early and repeatedly. Recently some success has inevitably been claimed for the sulphonamides.

Buboes which suppurate should be incised and dressed with iodoform.

Prevention consists in wholesale destruction of rats and the rat-proofing of food and grain stores. Ships require special attention to prevent rats from embarking and disembarking. Cases must be strictly isolated for a month and fomites destroyed or disinfected. The quarantine period is ten days.

Personal prophylaxis involves the avoidance of places where there are likely to be fleas and immunisation with one of the various *B. pestis* vaccines which unfortunately, are apt to produce severe reactions.

LEPROSY

Leprosy is a chronic infective disease characterised by granulomatous lesions of the skin and nerves caused by *Bacillus lepræ* (*Mycobacterium lepræ*). It is endemic in many tropical and sub tropical countries, but is prevalent only among primitive peoples. It is acquired by contagion through intimate personal contact over a long period and is not now thought to be hereditary.

Symptoms—After an incubation period of several years there is prodromal fever of variable severity and duration followed by the appearance of a pleomorphic rash associated with loss of hair, which occurs most commonly on the face, extensor surfaces of the limbs, or the trunk. The "period of specific deposit" follows, during which lepromata (tumours consisting mainly of small round cells and *B. lepræ* and comparable with tubercles in tuberculosis) are formed either in the skin or in the peripheral nerve trunks, or, occasionally, in both situations. In the first instance nodular or skin leprosy results, in the second, anæsthetic or nerve leprosy. In skin leprosy brownish, greasy, depilated patches occur which may later coalesce to produce, when the face is affected, the classical 'leonine facies' in which the eyes and nasal septum are eventually affected and the leper dies of intercurrent disease. In nerve leprosy the destruction of nerve tissue causes localised hyperæsthesia and anæsthesia, and, later, muscular atrophy, deformities, and trophic ulceration. The disease may persist for many years, being far more chronic than the skin form. *B. lepræ* can be demonstrated by the methods applicable to *B. tuberculosis* in smears made from the nasal discharge or the contents of the lepromata, but *B. lepræ* has not yet been successfully cultured.

Treatment—Apart from attention to general health and hygiene which is most important, chaulmoogra or hydnocarpus oil, though not specific, offer the best chance of delaying the progress of the disease. Among the numerous preparations available sodium hydnocarpate (alepol) is the most generally used, and is administered intramuscularly or subcutaneously in doses of 1 to 5 c.c. of a 3 per cent solution. Large doses of potassium iodide are given by mouth. Promising results have recently been reported from the injection of diphtheria anti-toxin and toxoid. Surgical intervention may be necessary in the treatment of corneal involvement, deformities, and leprotic

ulcers. Lepers, especially those with nasal discharge or open sores, should be segregated, and children born of lepers must be separated from them at birth.

YAWS

Yaws is a chronic contagious granulomatous disease with many similarities to syphilis (and of which syphilis is possibly a neurotropic form) common in tropical Africa, Malaya, the West Indies, and elsewhere. It is caused by *Spirochæta pertenuis* (which is indistinguishable from *S. pallida*), but is non-venereal and is never acquired hereditarily or congenitally. It is commoner in children than adults and in males than females.

Symptoms.—As in syphilis, there are three stages. A primary papule occurs at the site of inoculation and may develop into a fungating granuloma or "yaw" several centimetres in diameter and accompanied by some general constitutional disturbance. Several months later a secondary rash and numerous secondary yaws appear which have probably been spread from the primary yaw by scratching. Yaws resemble raspberries in appearance and have given the disease its synonym "*frambrasia*." In the tertiary stage extensive ulceration and bony deformities may occur, but visceral and nervous manifestations are unknown. The blood gives a positive Wassermann reaction, but the cerebrospinal fluid does not.

Treatment—Neosarsphenamine, preferably combined with bismuth, is specific.

RABIES

Rabies is a disease chiefly affecting dogs, wolves, and jackals, but occurs also in other animals, including cattle, horses, pigs, and cats. It is due to a neurotropic virus which invades the central nervous system via the peripheral nerves. It is transmitted by the bite of a rabid animal, the saliva of which contains the virus. The disease is common in tropical countries because of the numerous jackals and pariah dogs that are invariably at large there, but it also occurs in the arctic countries and all over the world, and has been stamped out in Britain only by the strictest quarantine regulations.

Rabies in the dog, because of that animal's highly developed intelligence, produces marked psychological disturbances. The animal becomes morose, irritable, and easily frightened, and

the bark changes in character. Later convulsions may occur and the dog crawls away to die. It rarely bites man or other animals unless they interfere with it. Sometimes the disease assumes a paralytic form. It is invariably fatal within ten days.

Rabies in Man—The incubation period varies with the severity and site of the bite but is generally between three and twelve weeks. The patient becomes depressed, irritable and hypersensitive to all stimuli. Reflex spasms of the organs of deglutition occur when attempts are made to eat and especially to drink and have given the disease as it occurs in man the synonym hydrophobia. Maniacal symptoms and paralysis may occur and within three days convulsive seizures give place to a rapidly fatal coma. Occasionally the disease may be paralytic in type from the onset. It is probably the most agonising disease to which man is heir, consciousness being retained almost to the end.

Treatment—No treatment is of any avail once the symptoms have developed.

Prophylaxis—Wild dogs should be destroyed and steps taken to keep pets away from them. In more civilised countries muzzling and quarantine measures should be enforced.

Inoculation with a vaccine of fixed attenuated virus aims at producing immunity during the incubation period and reduces the incidence of the disease in persons bitten by rabid animals from 16 to less than 1 per cent. Injections are given daily for periods up to twenty-one days according to the method of preparation employed.

Any person bitten by a possibly rabid animal should have the bite cauterised with carbolic or nitric acid and commence treatment immediately. The animal should be securely chained and if it is still alive at the end of ten days the patient has nothing to fear and may discontinue injections. If it should die or be killed the brain should be examined for the pathogenic oxyphilic granules (Negri bodies) which can usually be demonstrated in the ganglion cells of the hippocampus.

DISEASES DUE TO METAZOAN PARASITES

DISEASES DUE TO FLUKES

TRI MATODES or flukes a number of which are parasitic in man have a leaf shaped unsegmented body equipped with suckers. Only one variety is important in the production of disease in man, the Bilharzia (*Schistosoma*) infection with which produces bilharziasis.

Life History—There are numerous varieties of flukes which infest man, and the habitat of the adult may be in the intestine, the bile ducts, the lung and the blood vessels. Fertilised eggs are discharged in the feces, the urine, or the sputum, these eggs develop in water and produce a ciliated embryo or miracidium, which penetrates certain species of snail, after a period of development in the snail the organisms enter the water as cercariae, which may be either encysted or free swimming. The cercariae are either swallowed in drinking water or may burrow through the unbroken skin, and thus the life cycle is completed.

Bilharziasis (*Schistosomiasis*)—Two common forms of the disease are encountered, one due to the *Bilharzia haematobia* and the other to *Bilharzia Manson*. In both, the flukes inhabit the smaller veins, and produce eggs which are discharged into the bladder in the first type and through the wall of the colon in the second. The eggs are oval bodies of relatively large size (about 150μ in length), in the case of the *haematobia* variety there is a sharp terminal spine, while the *manson* variety has a lateral spine. The symptoms in bilharziasis are due not to adult flukes in the blood but to local irritation in the bladder or rectum from the passage of ova through the walls of the viscera.

Bilharziasis is widely distributed, particularly in Egypt and South Africa. Infection arises from bathing in water containing the free swimming cercariae which penetrate the intact skin. In some areas the disease is extremely common.

A third species, *Bilharzia japonica*, occurs in the Far East and causes an intestinal bilharziasis characterised in its later stages by great enlargement of the spleen and liver

Symptoms—In the disease due to *Bilharzia hæmatobia* the main symptom is hæmaturia, due to irritation of the bladder. At the end of micturition a few drops of blood are passed and numerous ova are found in the urine. Sometimes the chronic bladder irritation may lead to abscesses and calculi, but often the hæmaturia persists for years without serious symptoms. With the *Bilharzia mansoni* infections, the lower part of the colon and the rectum are mainly affected. The mucous membrane becomes thickened and polypoid, the stools contain blood and mucus, and ova are discharged in the fæces. In some cases the liver may become cirrhotic and ascites develop. Eosinophilia is often present.

Treatment—Intravenous injections of tartar emetic are most effective. The initial dose for an adult is $\frac{1}{2}$ gr in 10 c.c. of sterile saline, and the injection is repeated on alternate days increasing the dose up to a maximum of 2 gr. A total amount of about 25 gr should be given. Fouadin (Bayer) can be given intramuscularly. The initial dose is 1.5 c.c., on the second day 3.5 c.c., and subsequently 5 c.c. on alternate days until a total of 40 c.c. has been given. Anthiomaline (May and Baker) is also effective. Prophylaxis depends on avoiding bathing in infected water and the prevention of evacuation of urine or fæces near or into water.

DISEASES DUE TO TAPE-WORMS

Cestodes or tape worms inhabit the upper portion of the alimentary canal in man and other animals, and discharge their ova in the fæces. The ova are ingested by a secondary host, and larval forms develop in its muscles and other viscera. When the secondary host is eaten by the original host the larvæ are ingested and develop into mature tape worms.

In most cases of tape worm infection in man, the adult worm lives in the intestine, but in one important group, the *Tænia echinococcus*, the primary host is the dog, and development of the larvæ occurs in the viscera of man and produces what is known as hydatid disease. The tape worms which inhabit the human intestine are the following: (1) *Tænia solium*, (2) *Tænia saginata*, (3) *Dibothriocephalus latus*.

There is a great variation in the size and morphology of the different forms of tape worm, but generally speaking their

structure is similar, and consists of a head portion or scolex and a number of flattened segments which are posterior to the scolex. There is no alimentary canal, and the segments derive their nutrition by direct absorption of the intestinal contents. Each segment contains differentiated sexual organs, and when fully developed contains ripe ova. As the worm grows, segments are discharged in the feces.

Tænia Solium.—This tape worm is common in northern Europe. Its secondary host is the pig, which becomes infected by eating ova discharged in human feces. In the pig the ova develop into small oval vesicles, the *Cysticercus cellulosæ*, which are found in the skeletal muscles and are about 20 mm in length. If these are eaten by man the *Cysticercus* develops into an adult *Tænia solium* in the intestine. The *Cysticerci* are destroyed by cooking, and therefore the disease is only prevalent in countries where ham is eaten raw or partially cooked.

Tænia solium is 6 to 9 ft in length, with a globular head armed with a double circle of hooklets and four suckers by means of which it attaches itself to the mucous membrane of the intestine. The head is extremely minute as compared with the size of the ripe segments and does not exceed 2 to 3 mm in diameter.

Symptoms.—Often there are no symptoms beyond the passing of segments of the worm in the feces. Sometimes there is vague abdominal discomfort, with a voracious appetite. Usually there is no impairment of the general health, but the patient may become very neurotic. An eosinophilia is sometimes found, though anæmia is unusual.

Treatment.—The object of treatment in all types of intestinal tape worm infection is to effect a complete evacuation of the worm, including the head portion. If the latter remain it will produce further segments in the course of a few months. The drug which has a specific anthelmintic effect on tape worms is male fern. Details of treatment are as follows:—

The patient is put on a very light diet for two days before the male fern is to be administered, and the bowels are kept freely open with saline purgatives. Food is withheld entirely after midday on the second day of treatment. On the morning of the third day two doses of the following mixture are given at half an hour's interval. Ext. filicis liq ʒi, Syrup Zingiber ʒi, Gum acacia gr xxx, Aquam ad ʒi.

The male fern is liable to produce nausea, which may to some extent be avoided by taking a cup of black coffee between the doses. After the last dose of male fern a strong saline purge is taken to effect the discharge of the worm. Careful search

of the faeces should be made for the head of the worm : if this remains unpassed, segments may reappear in the stools in three months and a further treatment is required. Castor oil must be avoided when male fern is employed, as toxic effects may occur.

When treatment by male fern is unsuccessful, the active principle of pomegranate seeds, known as pelleterine, may be tried. This drug is given on an empty stomach in a capsule in doses of $\frac{1}{2}$ -4 gr., and is followed two hours later by a purgative.

Tænia Saginata.—This worm in the adult form is several yards long, and the head is equipped with suckers but no hooklets. The larval stage occurs in the cow, where it is known as the *Cysticercus bovis*. The cysts are found mainly in the muscles of mastication. The symptoms and treatment are similar to those described above.

Dibothriocephalus Latns.—This worm is very long and has an enormous number of broad segments. It is found chiefly around the Baltic, and the larval stage is passed in certain fish, the eating of which, insufficiently cooked, produces infection in man.

Infection with the *Dibothriocephalus* may produce a severe megalocytioanæmia. Possibly this is due to defective absorption of hæmopoietin (*vide* p. 348). Male fern is usually an effective anthelmintic.

Somatic Tæniasis (Cysticercosis).—The cysticercus cellulose stage of *Tænia solium* may occur in man. This results from ripe segments of the worm reaching the stomach during an attack of vomiting, or by accidental swallowing of the ova. In such cases the *Cysticerci* may develop in the muscles or brain, where they may produce epileptic fits.

HYDATID DISEASE

Whereas in the other forms of tape-worm the adult worm lives in man, in disease due to *Tænia echinococcus* the larval stage is passed in man, and the mature worm inhabits the intestines of animals, chiefly the dog. The disease, specially common in Australia, also occurs elsewhere. Human infection results from close contact with dogs, which discharge ova in their faeces. The worm itself is very minute, and does not exceed 5 mm. in length ; the head is provided with four suckers and a double row of hooklets ; there are only three segments, the last of which alone produces ova.

When the ovum is swallowed by man the embryo is liberated,

and ultimately reaches the blood stream after burrowing through the wall of the intestine. It may be carried in the blood to the liver, the lungs, the kidneys or the brain. Having eventually come to rest in one or other viscous most commonly the liver, the embryo is converted into a small cyst with two definite layers, an external laminated membrane and an internal parenchymatous layer, the endocyst. As a result of local tissue irritation a fibrous capsule is formed, shutting off the cyst from the surrounding tissues. As the cyst increases in size, buds develop from the inner parenchymatous layer and become daughter cysts, which again in turn produce granddaughter cysts. In this way the original cyst gradually enlarges and may contain large numbers of smaller cysts. From the inner layer of the cysts further buds arise which develop into brood capsules. These buds form scolices, which represent the head of the *Tania echinococcus* with its sucking discs and a circle of hooklets. The fluid in the cyst is clear and non albuminous with a specific gravity of about 1.005, and the characteristic hooklets may be found in the fluid.

The echinococcus cysts may remain alive for an almost indefinite period, but sometimes they die and the cyst becomes inspissated and sometimes partly calcified. In other cases rupture takes place as the cyst enlarges, and the daughter cysts and scolices are discharged into the lung, peritoneum, pericardium or to the exterior. Lastly, the cyst may become infected and suppurate.

Approximately 70 per cent of hydatid cysts occur in the liver. The symptoms produced will depend entirely on the site of the cyst and on such accidental occurrences as its rupture or suppuration.

Hydatids of the Liver—The liver may become very much enlarged as the result of the presence of hydatids. The physical signs will vary with the part of the organ which is involved. If the cyst is in the right lobe near the posterior surface the liver is enlarged upwards towards the pleural cavity, and there is dullness on percussion over the right base and in the posterior axillary line. With great enlargement there is bulging of the right side of the thorax, especially in the lower portion. When the cyst occupies a position in the anterior part of the liver a swelling may be felt in the epigastric region which has a tense, firm feeling and a smooth surface. When the cyst is superficial a *hydatid thrill* may occasionally be elicited if the tumour is palpated with one hand and tapped gently with the fingers of the other hand. With cysts in the left lobe of the liver the heart is displaced

upwards, and there is an increased area of dullness in the left hypochondrium

Symptoms may be completely lacking, and there is seldom any general disturbance of health. With large tumours there may be sensations of dragging or pressure in the region of the liver.

With suppuration serious symptoms develop and the case resembles one of hepatic abscess, with rigors, pyrexia, sweating and sometimes jaundice. If the cyst perforates into an adjacent viscus, its contents may be coughed up should the perforation be into the lung, or in the case of perforation into the alimentary tract, portions of the cyst may be vomited or passed in the feces.

The diagnosis of hydatid cyst may be suspected when there is marked hepatic enlargement which has been observed to be present over a long period without impairment of health. The condition has to be differentiated from growths of the liver, syphilitic cirrhosis, tropical or other abscesses, and right-sided pleural effusions. Points in favour of hydatid are bulging of the chest wall, a smooth surface to the tumour, and the presence of the hydatid thrill. Eosinophilia is common in patients with hydatid disease, and a blood count is always advisable with obscure hepatic enlargements. As a further aid to diagnosis a complement fixation test may be performed but the results of the test cannot be regarded as conclusive. This is also true of the skin reaction test of Casoni, in which a few drops of hydatid fluid are injected intradermally. The immediate appearance of an urticarial wheal at the site of injection usually indicates that the patient harbours hydatids.

Hydatids of the Lung and Pleura.—The cysts compress the lung, and ultimately lead to hæmoptysis, inflammation and gangrene.

Hydatids of the Kidneys.—This condition is rare. The kidney may be converted into an enormous cyst resembling a hydronephrosis. Small cysts and hooklets may be passed in the urine, with accompanying attacks of renal colic.

Hydatids of the Nervous System.—Symptoms of cerebral tumour are produced with headaches, convulsions, and sometimes insanity.

Treatment of Hydatids.—Unfortunately, no drug has any effect upon hydatids. Treatment is entirely surgical and in the case of hydatids of the liver involves either complete removal or drainage of the cyst. Care must be taken to avoid dissemination of the cysts in the course of operation.

DISEASES DUE TO ROUND WORMS

There are a number of Nematodes or round worms which infect the human intestine. The most important of these are *Ascaris lumbricoides*, *Enterobius vermicularis*, *Trichuris trichiura*, *Ankylostoma* and *Trichinella spiralis*. In addition to the intestinal nematodes, the *Filarioidea* inhabit the lymphatic vessels, and the guinea-worm the tissues of the foot. Unlike the tape-worms, round worms have an alimentary canal and are not composed of separate segments.

Ascaris Lumbricoides.—This worm is 6 to 10 in. in length and reddish-brown in colour. Ova are passed in the feces. These are brown oval bodies about 70μ in length and 60μ in width. Autoinfection can take place by their transfer from the anus to the mouth.

Usually *Ascaris* is found in the small intestine, but sometimes the worms may enter the stomach and be vomited. More rarely they have been found blocking the common bile-duct or in the appendix. Often no symptoms are produced. Sometimes, however, the presence of round worms may lead to the passage of blood and mucus in the stools, which may be mistaken for dysentery; more often flatus and distension are troublesome symptoms. Should a worm die and remain in the upper intestine, toxic absorption occurs, with pyrexia and vomiting. The worms are often passed in the stools, and a patient who knows himself to be infected is liable to develop various neuroses.

Treatment.—Santonin (2 to 5 gr.) is given on three successive nights followed by castor oil in the morning. Occasionally it produces vertigo and yellow vision.

Oxyuriasis.—The *Enterobius vermicularis*, often known as the *Oxyuris vermicularis*, is the thread-worm, which inhabits the colon and particularly the rectum. It is only about $\frac{1}{2}$ in. long. Ova and worms are found in the feces, and the main symptom produced is itching round the anus, particularly at night. The patient is usually a child, and the most satisfactory treatment is to wash out the rectum and lower bowel with an infusion of quassin (1 in 40): this procedure should be repeated every other day for a fortnight. Saline purgatives will help to dislodge the worms, and the itching is treated by application of ung. hydrarg. nit. dil. It is important to avoid autoinfection by washing the hands and perineum thoroughly after defaecation.

Trichuris Trichiura (*Trichocephalus dispar*)—This worm is commonly known as the whip worm, and is about $1\frac{1}{2}$ in length. The hinder portion of the worm is very thick and the anterior thin and hair like, a peculiarity which gives rise to its popular name. No symptoms are usually produced. All forms of treatment are ineffective.

Ankylostoma Duodenale—Whereas all the round worms described above produce but few, if any, symptoms, the ankylostoma or hook worm is a serious menace if not to life at any rate to health, and produces the disease known as ankylostomiasis. The parasite exists in almost all parts of the world, but particularly in the tropics. Epidemics have occurred among miners in Cornwall, Germany and Switzerland.

Life History—The adult worm is about 10 to 15 mm in length and the mouth is provided with two pairs of sharp hook shaped teeth with which it pierces the mucous membrane of the intestine. The ova are passed in the faeces, and if they fall upon warm soil they develop into larvæ which are able to penetrate the intact skin. After entering the veins they pass upwards through the heart into the pulmonary circulation from which they burrow into the bronchi. They then ascend through the trachea, and after passing the larynx go down the œsophagus to develop into adult worms in the upper part of the small intestine.

Infection occurs in man if the feet are exposed to mud or water in which the embryo worms are present. This explains epidemics among workers in mines and tunnels. The disease can only occur where proper sanitation is lacking.

Ankylostomiasis—The parasites produce a local lesion at their site of entry which is most commonly on the feet or hands. Small vesicles and pustules are formed, with some local inflammation which subsides in the course of a few days. The local lesions are described as "ground itch."

The general symptoms depend partly on the number of worms which infect the intestine and partly on the reaction of the individual patient. In many regions as many as 90 per cent of the population are infected, as judged by the finding of ova in the faeces, but only a proportion show symptoms.

The main clinical features are hypochromic anemia, abdominal discomfort, failure of nutrition and lassitude. In children growth is markedly stunted. The hemoglobin may fall to 30 per cent with marked œdema and death may occur from exhaustion and intercurrent infections. Eosinophilia ranges from 10 to 30 per cent. Gastro intestinal symptoms are sometimes present and perversions of appetite occur, as

the result of which patients may eat earth, clay, hair, or paper. Severe anemia causes dyspnea and cardiac dilatation.

Diagnosis—This can be made definitely by the discovery of ova in the feces, these are oval bodies about 60μ in length and 40μ in breadth. The ova have thin transparent capsules enclosing a number of cells. Eosinophilia with anemia is highly suggestive of ankylostomiasis.

Prophylaxis and Treatment—The Rockefeller Foundation has inaugurated a world wide campaign against ankylostomiasis, which is already producing satisfactory results. In the prophylaxis of the disease sanitation is of the greatest importance, and with properly constructed latrines the incidence of the disease is greatly decreased. When the disease is prevalent the population must be educated to understand the dangers of indiscriminate defecation, and also the necessity for treatment of infected individuals.

As an anthelmintic tetrachlorethylene is safe and effective. Four cubic centimetres are given in a single dose shaken up in 8 drachms of Epsom salts. This is taken in the early morning, and the salts are repeated in three hours if the bowels are not opened. Thymol is also employed. In adults three cachets of 30 gr. each are given at two hourly intervals followed by a saline purge. Thymol is soluble in fats and alcohol which must therefore be avoided during treatment. Two further treatments should be given at weekly intervals.

Trichinella Spiralis—This is an extremely small worm which inhabits the small intestine. The disease known as trichiniasis is produced, not by the presence of adult worms in the intestine, but by the migration of their embryos into the muscles.

Life History—The adult worm inhabits the intestine of the pig, and produces large numbers of embryos which penetrate the wall of the gut and enter the blood stream, by which route they ultimately reach the skeletal muscles. Lodged in these they develop into small cysts about $\frac{1}{2}$ mm. in length. Within the cyst lies the embryo worm in a spiral coil. No further development takes place unless the flesh of the infected animal is eaten by man or other animal. If this occurs the cyst wall is digested and the trichinella embryo rapidly grows into an adult worm in the intestine. The worm produces large numbers of larvae, which migrate to the striated muscles, where cysts are formed. The encysted trichina may remain alive for many years, but in course of time the cysts may calcify, and are also readily destroyed by heat.

Trichiniasis—This results from eating infected pork which

has been insufficiently cooked and is relatively common in Germany. Careful inspection of meat before distribution and the avoidance of raw or partially cooked ham prevent the dissemination of the disease.

Symptoms—Soon after eating infected meat there may be abdominal pain vomiting and diarrhoea but very often these symptoms are slight. The more serious symptoms arise between the seventh and the tenth days after infection when the embryos are passing from the intestine to the muscles. At this stage there is usually considerable fever and the migration of the parasites into the muscles causes an acute myositis with much tenderness and pain. The temperature may simulate that of typhoid fever. A secondary anaemia develops and the leucocyte count is high with a great increase in the eosinophils. Oedema of the eyes is often a striking clinical feature. In protracted cases there is much emaciation.

Diagnosis—This may be made definitely by the removal of a small portion of muscle, in which the trichina cysts can be seen or by finding the larvae in samples of the pork which the patient has eaten. Eosinophilia occurring in a case of continued fever should also rouse suspicion. The disease has to be differentiated from typhoid fever and acute rheumatism. In the latter disease the pain is in the joints and not in the muscles while in typhoid leucopenia and the absence of muscular pain and tenderness will assist in the diagnosis.

Treatment—No satisfactory treatment is available which will affect the encysted embryos but the alimentary canal should be cleared of the adult worms by calomel castor oil and salines. When the muscular pain is severe it must be relieved by sedatives.

Filariasis—Several different genera of the order of filarioidea have been described and are widely distributed in the tropics. The adult worms are thread like organisms approximately 2 in long which inhabit the lymphatic system. They produce embryo worms which are less than $\frac{1}{2}$ mm in length and of the diameter of a blood corpuscle. In the case of *Wuchereria bancrofti* the embryos appear in the peripheral blood during the night or while the patient is sleeping. For the full cycle of development to occur an insect (e.g. mosquito in the case of *W. bancrofti*) is necessary as a secondary host. The latter on sucking blood from an infected person withdraws with the blood a number of filaria embryos which undergo stages of development in the body of the insect. Ultimately the larvae reach the proboscis and thus infect human beings.

Infection with filaria produces various symptoms dependent

on obstruction of the lymphatics by the adult worms. The parts of the body most commonly affected are the legs and the scrotum where the blockage of the lymphatics produces the condition known as *elephantiasis*, in which there is marked thickening and brawny oedema of the parts involved. A remarkable symptom which sometimes occurs in filarial infections is chyluria, from time to time the patient passes white opaque urine which resembles milk. This phenomenon is due to a rupture of lymphatic vessels into the urinary tract.

There is no effective treatment for filarial infection, but chyluria may be diminished by restricting the amount of fat in the diet. Where the elephantiasis is localised as in the scrotum, surgical removal is indicated.

Guinea-Worm—This worm occurs in parts of Africa and in the East Indies. It is found subcutaneously in the neighbourhood of the feet, where it forms a palpable coiled mass under the skin. Eventually the head of the worm ulcerates through the skin and living embryos are discharged to the exterior. These develop in water and are ingested by a small crustacean the cyclops in which they develop. If the cyclops be swallowed in drinking water the larvae grow into a mature worm which later burrows from the intestine into the leg.

The head of the worm may be seen in the base of the ulcer. After discharging its embryos it often leaves the body spontaneously. Natives who are affected with guinea worm roll it around a small stick, and each day wind a little more out until the entire worm is withdrawn. Care must be taken not to rupture the worm, which is about 18 in. in length.

J. J. CONYBEARE

DISEASES OF INFANTS

DISEASES OF THE NEWLY BORN

AT birth, and in the period immediately subsequent to birth the infant is exposed to many hazards. Should he survive the perils of the progress through the maternal passages, he is then extruded into an environment vastly different from the one in which he has hitherto developed. Many functions previously carried out by the mother have now to be performed by the infant, and during this period of adaptation and adjustment many diseases may develop, with the more common of these this section is concerned.

1 **INANITION FEVER**—Slight variations of temperature are seen in many newly born infants, for the heat-regulating centre is immature, and therefore does not function efficiently. In some infants a considerable degree of fever develops between two and four days after birth. The temperature may rise to 104° or 105° F. There is restlessness, irritability, rapid and extensive loss of weight and a tendency to suck eagerly at any object within reach. Within a few hours signs of collapse appear: the cry becomes weak, the pulse feeble, and the fontanelle sunken. *This is known as inanition fever.*

Infants with this condition are either being nursed on dry breasts, or, if artificially fed, are receiving an insufficient supply of fluid. When water is freely given the temperature rapidly falls, and in a few hours recovery is complete. Therefore the best method both of preventing and treating inanition fever is to ensure an adequate supply of fluid to the newly-born.

2 **ATELECTASIS**—Pulmonary atelectasis is the term applied to the collapse of lung sometimes seen in the newly born. Cases of atelectasis may be classified in two groups: in the first the lungs, after having been fully expanded, collapse either through weakness or immaturity; in the second group the lungs have never been completely expanded. In these children it is usual to find a history of asphyxia immediately after they were born.

Atelectasis gives rise to no clear clinical picture. The infant is feeble, the cry weak, attacks of cyanosis occur, particularly after feeding; in others the cyanosis may be more or less constant. The physical signs are of little help in the recognition of this condition; the breath sounds are weak, fine crepitations may be heard over the posterior aspects of both lower lobes, and occasionally some inapirment of the percussion note is found in these same areas. The prevention and treatment of this condition is to ensure that the infant expands his lungs fully at least twice a day, which is best accomplished by spanking and the use of alternate hot and cold baths. Nursing in the arms is also of value, and every attempt must be made to ensure that these infants receive an adequate amount of food. The affection is serious and is sometimes the cause of sudden death in the newly-born.

3. **ICTERUS NEONATORUM.**—Icterus neonatorum is noticed in more than half of all newly-born infants. It appears from the second to the fifth day after birth, increases in intensity for three or four days, and then gradually fades. It is usually not noticeable after the end of the second week. Apart from the discoloration, these jaundiced infants appear to be healthy; they nurse well, are contented, neither the spleen nor the liver is enlarged, and both the stools and urine are normal. Icterus neonatorum is the result of an increase of bilirubin in the blood of the newly-born; the increase is produced by hæmolysis of red blood cells which takes place in the first few days after birth. This hæmolysis occurs in all infants and it is the means by which the erythræmia of foetal life is corrected. It is presumed that in some newly-born infants the immature liver is unable to deal with this excess of bilirubin and in such infants icterus neonatorum occurs. Jaundice in premature infants is not to be constant and severe; this is explained by the supposition that the liver of the premature performs its function in relation to the bilirubin even less completely than the liver of the full-time child.

Icterus neonatorum is not the only variety of jaundice found in the newly-born. Congenital occlusion of the bile ducts, syphilitic hepatitis, and sepsis may all produce jaundice which may be confused with icterus neonatorum. In congenital occlusion of the bile ducts the infant is jaundiced from birth, the stools are pale, the discoloration gradually increases in intensity, and death takes place in several months from malnutrition. In syphilitic hepatitis other signs of syphilis are

usually present. In jaundice caused by septic infections the general bad condition of the child will point to the diagnosis.

Icterus neonatorum requires no treatment.

4. **HÆMORRHAGIC DISEASE OF THE NEWLY-BORN.**—The newly-born infant may bleed into the skin and viscera, or from the mucous membranes; in either case the cause may be injury during birth or a general septic infection. Quite apart from these conditions some infants bleed without any apparent cause during the first ten days of life; this condition is known as hæmorrhagic disease of the newly-born.

The bleeding in this disease takes place from the mucous membranes, usually from the intestine, and the blood is passed per anum; occasionally blood is vomited, and at times oozing takes place from the stump of the umbilical cord or from the mouth. The period of time during which this bleeding is most likely to occur is from the second to the fifth day of life; it does not occur after the tenth day.

The cause of the disorder is unknown; some observers believe that it is due to some kind of infection. The clotting time of the blood is often delayed. Diagnosis is usually easy, as the hæmorrhage in most cases is external; some confusion, however, may arise when infants vomit blood derived from lesions either of their own mouth or of the maternal breast. Treatment is usually satisfactory. In the severe cases transfusion of 50 to 100 c.c. of blood is required. In mild cases intramuscular injections of 30 to 40 c.c. of blood are indicated. These injections may be repeated if necessary.

5. **SEPSIS IN THE NEWLY-BORN.**—The aseptic management of birth has very greatly diminished the incidence of sepsis in the newly-born. Infection may take place either through the thin skin or the open wound of the umbilical stump. The resulting infection may be either local or general, but in many cases local infection may subsequently become generalised. In both cases symptoms are evident before the twelfth day. Local infection manifests itself in several ways: in inflammation of the umbilicus, so-called omphalitis; in erysipelas around the umbilicus; in the formation of bullæ on the skin, known as pemphigus neonatorum. General infections produce wasting, fever, hæmorrhages, jaundice, and areas of suppuration situated anywhere in the body. The diagnosis of these conditions does not usually present difficulty. Pemphigus neonatorum is to be distinguished from syphilitic pemphigus. In the latter the bullæ are found on the palms and soles, and other evidence of syphilis is present. The treatment is symptomatic. Collections of pus need to be dealt with on the usual surgical lines.

THE GASTRO INTESTINAL DISORDERS
OF INFANTS

The gastro intestinal disturbances of infants are of great importance. They are very common, and are a frequent cause of death, many of them can be prevented and most are amenable to treatment. These disorders consist of symptoms or combinations of symptoms derived from the gastro intestinal tract and produced by widely different causes. When prolonged they lead to profound alteration in the nutritional state. The disturbances to be considered are colic, constipation, vomiting, diarrhoea, and wasting or atrophy.

Ætiology—The causes of these disturbances are to a great extent covered by a consideration of the four factors—food, infection, environment, and constitution.

1 *Food*—This is an important element in the cause of these conditions. The food as a whole may be unsuitable. It may be excessive in amount, resulting in colic, vomiting and diarrhoea, it may be insufficient with the production of constipation and wasting. Apart from the food as a whole, the individual constituents may be at fault. The protein may be excessive, giving colic and constipation, the carbohydrates and fats in too large quantities may cause diarrhoea and vomiting, lastly, in certain instances the water content of the diet may be too low, with resulting fever and collapse.

2 *Infection*—As a cause of gastro intestinal disturbances, infection may act in two ways. Firstly, there may be a direct infection of the gastro intestinal tract by various micro organisms producing fever, vomiting, and diarrhoea. These infections usually take place through the medium of the food, and are known as enteral infections. Secondly, an infant may have an infection not involving the gastro intestinal tract such as otitis media, pyelitis, or bronchitis and yet may show severe gastro intestinal symptoms, vomiting, diarrhoea and wasting. When infections of this nature occur, they are known as parenteral infections. These conditions are common and are of very great importance.

3 *Environment*—The influence of the environment in the production of gastro intestinal disorders is important. Heat plays a great part in the incidence of diarrhoeal conditions by depressing the vitality of the child by lowering the tolerance for food, and by facilitating the growth in food of harmful micro organisms. Exposure to cold is a potent factor in the production of colic. General bad hygienic conditions are

obviously of importance in allowing food infection to take place

4 *Constitution*—Certain constitutional defects for example congenital morbus cordis, hydrocephalus, and birth palsy produce gastro intestinal symptoms such as wasting and constipation. A neurotic constitution is often alleged to be a cause of vomiting. The fat and flabby infant with the so-called exudative diathesis is prone to diarrhoea.

This outline of the factors concerned in these disorders must be completed by pointing out that gastro intestinal symptoms may and do occur in various diseases associated with organic changes in the gastro intestinal tract or elsewhere in the body. For example, vomiting accompanies increased intracranial pressure, both vomiting and constipation occur in obstruction of the intestinal tract. In such conditions, however, the gastro intestinal symptoms are but incidents in the course of the disease and are usually overshadowed by the other signs and symptoms present.

With this general consideration of the causes of these disturbances in mind, a brief outline of the clinical features and treatment of these conditions may be drawn.

Colic—This disorder is most often seen in the first three months of life. The symptoms are somewhat characteristic and usually point plainly to the diagnosis. Screaming attacks of short duration and drawing up of the legs with immediate relief on the passage of flatus, are observed. Colic is often associated with constipation, and at times with diarrhoea. The cause is usually to be found in some fault in the diet though chilling of the body surface often plays an important part. Air swallowed with the food is at times responsible. Treatment should be directed to the cause. Any fault in the composition or in the quantity of the food must be corrected. During the actual attack, warmth applied to the abdomen and a small enema of warm water give relief. Small doses of carminatives are of value while the cause is being detected and remedied.

Constipation is a common symptom in gastro intestinal disturbances. There are two important causes—insufficiency in the amount of food, which is a frequent cause in the breast fed infant—too little carbohydrate in the food which is seen in the artificially fed. Quite apart from these, constipation occurs as a symptom in organic disease, such as intestinal obstruction, Hirschsprung's disease, and painful lesions of the anus. These must all be excluded by careful examination. In the constipation caused by insufficient food, loss of weight is

an important additional sign. The treatment must be directed to the cause, and the necessary alterations must be made to the diet. Drugs should play a small part in the treatment. If any are required, liquid paraffin, either alone or in association with small doses of milk of magnesia, will be found of value.

Vomiting—Vomiting, as a symptom of gastro intestinal disturbance, is very common in infancy. The causes are various and have already been dealt with to some extent.

Vomiting may be divided into two categories: vomiting alone, and vomiting in association with diarrhoea. The latter will be considered in the section devoted to diarrhoeal disturbances, the former only is considered here. The causes of vomiting without diarrhoea may be classified in two groups. In the first group the causes are mainly mechanical: air swallowed during feeding, tight binders around the abdomen, excessive handling after feeding, and gastric distension produced by overfeeding. In the second group vomiting occurs without any apparent cause in a lively, apprehensive infant who is cared for by an anxious, somewhat excitable mother; in these infants the diagnosis of "nervous vomiting" is made.

The symptom these two groups exhibit is vomiting usually soon after food, accompanied by a progressive loss of weight.

The diagnosis is often somewhat confusing and the cause sometimes difficult to determine. Care must be exercised to distinguish those infants in whom the vomiting depends on an organic lesion, such as congenital stenosis of the pylorus, increased intracranial pressure, or intestinal obstruction. The treatment is to correct the cause wherever possible to decrease the amount of the feeds, and lengthen the intervals between the feeds. Success is sometimes obtained by making the feeds of a semi solid consistency and feeding with a spoon. Atropine is sometimes of value, beginning with 1 minim of a 1 in 1,000 solution of atropine sulphate by mouth. The dose should be increased by 1 minim at alternate feeds until physiological effects are produced. In "nervous vomiting" the replacement of the anxious mother by a quiet, efficient nurse is of value. Often chloral hydrate, gr. 1 to 2, about a quarter of an hour before feeding, will be of value.

Diarrhoea.—The highest death rate is found in those nutritional disturbances of which the main symptom is diarrhoea. Vomiting is usually associated with the diarrhoea but as a rule it is neither as prominent nor as persistent a symptom. The causes of these disturbances have already been outlined above, but owing to their importance the brief account there given must be a little amplified. Improper food is perhaps the

most frequent cause The usual fault found is an excess of sugar combined with a high percentage of fat As a general rule it may be stated that it is unsafe to give a percentage of total sugar higher than 10, and the fat percentage should not exceed 3.5 The disturbance produced by a high fat and sugar content in the diet is known as "fermentative dyspepsia" The symptoms are due to the fermentation of the excess of sugar with the production of acid bodies which irritate the gastric and intestinal mucosa Apart from the composition of the food an excess of food of proper composition may give rise to fermentative dyspepsia Environmental conditions, such as heat and poor hygiene, are potent factors in the production of diarrhoea, and their influence is more than ever apparent when the food given is faulty Heat lowers the normal tolerance for food and, by increasing the need for water, produces thirst The infant then cries, and this is interpreted as being due to hunger, more food is then given, so that he is overfed at a time when the food should be reduced, and thus fermentative dyspepsia is set up

Infection, both enteral and parenteral, has been mentioned as causing diarrhoea and vomiting Parenteral infections are of particular importance, on only too many occasions has a correct diet, even breast milk, been blamed for producing diarrhoea and vomiting when the disturbance has been due to an overlooked parenteral infection

The symptoms are of all grades of severity In mild cases increased bowel movements are all that is observed In more severe cases, vomiting is usually added to the diarrhoea, and there may be considerable excoriation of the buttocks by the acid irritating stools The general symptoms may be slight but in the severe examples the infant passes into a state of so called "intoxication" In this condition the child lies stuporous with sunken, half closed eyes, the arms are flexed and crossed on the chest in the so called "boxer position" the fontanelle is sunken, the skin inelastic, and there is a greatly diminished excretion of urine Sometimes symptoms indicating a diminution of the alkali reserve of the body become apparent, the infant becomes comatose, the breathing deep and plainly audible, the lips cherry red in colour

In some cases the whole disturbance is extremely acute, and death may ensue within twelve hours

The stools are variable, in the milder cases they are liquid and often green in colour In severe cases they may be like rice water When blood is present, an enteral infection by a dysenteric organism may be suspected The diagnosis is

usually made without difficulty, but if older infants have blood in the stools the possibility of melaena must be considered.

Treatment is of great importance. Search is to be made for any parenteral infection which must be treated if found. Starvation should be instituted as soon as the diagnosis is established. The length of time for which this should be continued depends on the state of nutrition of the infant. As a general rule it may be stated that food should not be withheld for more than twenty four hours, in infants of poor nutrition only six hours of starvation are necessary. From the beginning of treatment fluids should be administered at least 3 oz for each pound of body weight or as much more as the child will take, in the twenty four hours, half strength normal saline may be used. In addition to this fluid given by mouth most infants will require intraperitoneal injections of saline. It may be given in such quantity as to produce slight abdominal distension. If distension be already present before treatment, fluid is to be given by the subcutaneous route. All cases should receive colon washes at the outset of the illness. If vomiting is a feature, a stomach wash is of value and may be repeated when necessary. As soon as the period of starvation has ended feeding is to commence. Skimmed dried milk in a 1 in 10 dilution with water and added carbohydrate in the form of 'dextrin maltose' should be given. The strength of the added carbohydrate is 1.5 per cent for the first two days, 3 per cent for the next two days and then the amount may be raised to 6 per cent. The amount of this mixture to be administered should be about 4 oz at two hourly intervals, with ten feeds in the twenty four hours.

The feeds themselves should be increased by 2 dr per feed every twenty four hours for three days, after that time amounts of $\frac{1}{2}$ to 1 oz may be added according to the patient's condition. After three days the intervals between the feeds may be increased so that the child receives seven feeds in twenty four hours. As a general rule it may be stated that milk containing a higher fat content than skimmed milk (0.08 per cent fat) should not be given before the tenth day. As regards drugs, if the patient is seen at the outset of the illness a dose of $\frac{1}{2}$ to 1 dr of castor oil may be given, apart from this, drugs play no part in the treatment. It is as well to treat infants with diarrhoea as one would a typhoid patient as to disposal of nappies and excreta. In patients with symptoms of acidosis glucose in a 5 to 10 per cent solution may be given by mouth. Sodium bicarbonate is of secondary importance,

but 15 to 30 gr may be given four hourly until the urine becomes alkaline. Medication should then cease.

Wasting or Atrophy.—This symptom may be primary, but it often results from prolonged gastro intestinal disorders, such as vomiting and diarrhoea. The essential cause of wasting is an inability to obtain or absorb enough food. There is underfeeding, either because the child actually receives insufficient food, or the diet, though suitable, is vomited or, again, because intestinal conditions do not allow ingested food to be absorbed. In each case wasting results.

It cannot be over emphasised that the most common cause of wasting is underfeeding. Particularly is this the case when constipation is also present. In all cases of infants with wasting the amount of food not necessarily offered but actually being taken is to be investigated and its composition reviewed.

Other causes of wasting are numerous, but not of such great importance. It is seen in children with "constitutional defects" such as congenital morbus cordis and cerebral palsy, it is associated with infections such as congenital syphilis, sepsis, tuberculosis, and empyemata. Infants with wasting are sometimes divided into two categories: firstly, those with so called "simple wasting" or "atrophy", secondly, those with "atrophy with dyspepsia," sometimes termed marasmus. The first condition is due to a simple lack of food, and when a proper diet is given immediate improvement is seen. Atrophy with dyspepsia is seen in infants with a long history of gastro intestinal disturbances, by which the tolerance of the intestinal tract for food has been lowered. When these infants are given a suitable diet, there is an immediate recrudescence of symptoms and further loss of weight. This so called "paradoxical reaction to food" distinguishes atrophy with dyspepsia from simple atrophy. The treatment of wasting is first of all the treatment for the cause of the symptom, whenever this is possible. Any infection present must be dealt with, and the diet, both as regards its quantity and its quality, must be investigated. Most important of all is to remember that a wasted infant requires an amount of food proportionate not to what he actually weighs, but to what he should weigh if he were normal. This feeding for expected weight is the most valuable therapeutic measure that can be adopted, and by it brilliant results are achieved.

The treatment of atrophy with dyspepsia is to be conducted on the lines laid down for the treatment of diarrhoea, but in this condition no preliminary period of starvation is necessary, and the food may be increased somewhat more quickly to the

amount required for the expected weight of the infant. Infants with dyspeptic atrophy do well on human milk if it can be obtained, but in many cases, as may be realised from the definition of the condition, treatment is of little avail.

HYPERTROPHIC STENOSIS OF THE PYLORUS IN INFANTS

Ætiology—Two views are held concerning the cause of this disorder, neither view completely explains the condition. Some observers regard the muscular thickening as being in the nature of a hypertrophy secondary to prolonged and oft repeated spasm of the pylorus—no adequate explanation of the cause of this spasm has been put forward. The second view is that this hypertrophy of the pyloric muscle is simply a congenital deformity parallel to such conditions as hare lip and congenital morbus cordis and to this deformity spasm is subsequently added. It is known that first born children are more prone than others to congenital deformities, and hypertrophic stenosis is more frequent in the first born.

Clinical Features—This disorder usually occurs in male first born infants, and is observed in the second or third week of life. It is rare for the onset to occur during the first week, its occurrence is still more rarely seen after the third month. The cardinal signs are five in number—vomiting, constipation, loss of weight, visible gastric peristalsis, and the presence of a pyloric tumour. The vomiting is projectile in character and may occur after every feed or at less frequent intervals. The vomitus consists of ingested food and much mucus. On a change of diet the vomiting often diminishes in frequency for several days. Constipation is constant and severe, and from the point of view of the diagnosis, its presence is of importance. Wasting is a prominent feature, in mild cases however, it may be slight. The peristalsis is evident on examination immediately after the infant has been fed. Rounded swellings of about the size of a golf ball will be seen to pass across the epigastrium from left to right. In the great majority of infants with this condition the thickened pylorus may be palpated. On abdominal examination it is felt as a hard mass of the size of a hazel nut in the right hypochondrium. Efforts to feel this tumour should be made immediately after feeding and before success is attained the examination may have to be repeated several times. Evidence of gastric retention can be obtained by passing a stomach tube or by an X ray examination.

Morbid Anatomy—The pylorus is thickened and hard almost cartilaginous, owing to hypertrophy of the circular muscular fibres. The stomach is dilated and its wall hypertrophied. A chronic gastritis with excessive mucous secretion is often observed.

Diagnosis—Difficulty in diagnosis usually arises from confusing the vomiting of hypertrophic pyloric stenosis with that in nutritional disorders. As, however, in the latter diarrhoea rather than constipation is usually present in some degree, the presence of constipation in this instance is of importance. Vomiting, of course, may be a symptom of other constitutional disturbances, such as increased intracranial pressure, but in these conditions neither visible gastric peristalsis nor a pyloric tumour is present. A pyloric tumour will be found in the great majority of cases if careful and repeated examinations are carried out, indeed some observers will not commit themselves to a diagnosis of pyloric stenosis unless a pyloric tumour can be felt. It is the author's personal opinion that a diagnosis of pyloric stenosis may justifiably be made although no enlarged pylorus can be felt. The possibility of stenosis of the pylorus of infants is to be kept in mind in all cases of persistent vomiting in young infants. Few cases will then be overlooked.

Treatment—Infants with pyloric stenosis require surgical treatment unless symptoms are mild. The operation of election is a division of the muscular fibres of the pylorus, the Fredet-Ramstedt operation. No less important than the operation itself is the management of these patients both before and after the operation has been performed. Many of these infants have been weaned under the mistaken impression that the breast milk was the cause of the symptoms, this action is to be deplored, as the outlook is considerably worse in the artificially fed. Before the operation, stomach washes are to be given twice daily and, immediately before the anæsthetic is administered, 100 to 200 c c of saline and 4 per cent glucose solution may be given per rectum.

After the operation the infant should be placed in bed on the right side with the head a little raised. Feeding is to commence as soon as the infant has recovered from the anæsthetic. In the breast fed, 1 dr of expressed milk is given at two hourly intervals, in between these feeds a similar amount of boiled water is administered. The amount of the feeds is increased every six hours by approximately $\frac{1}{2}$ dr, and the intervals between the feeds are also lengthened, so that in forty-eight hours after operation 1 oz of milk is taken every

three hours, with a similar amount of water in between the milk feeds. On the third day after operation the infant may be nursed at the breast at three hourly intervals. The artificially fed are to be given feeds of half cream dried milk in the same amount as the breast fed, and forty-eight hours after operation the full amount for the weight may be given.

The mild cases in which medical treatment is tried should be re-fed immediately after vomiting takes place, if vomiting persists, the expedient of thickening the feeds may be given a trial. One pint of a milk mixture with four or five table spoons of barley flour is cooked until the resulting mixture is of a semi solid consistency. 1 to 2 oz are then given by a spoon. The necessary amount of water is given between feeds. Recently 25 cc of Eumydrin (1 in 10 000 solution) given half an hour before feeds has produced recovery, even in severe cases. This drug, given after dehydration has been corrected, may be considered as an alternative to surgical treatment in certain cases.

Results—The outlook in pyloric stenosis is on the whole, favourable, but is modified by several factors. Breast fed infants show a much higher rate of recovery than the artificially fed. The amount of weight lost is of importance, if this is over a quarter of the birth weight, the outlook is bad.

INFANTILE SCURVY (*Barlow's Disease*)

Ætiology—A diet deficient in vitamin C is the cause of scurvy. The proof of this statement rests on three facts—firstly, scurvy can be produced at will in animals by withholding substances containing vitamin C from their diet, secondly, scurvy is seen in infants whose diet is deficient in vitamin C, thirdly, both in infants and in animals scurvy is cured both quickly and completely by the giving of substances known to be rich in vitamin C.

Vitamin C is found in varying amounts in all fresh fruits and vegetables, it is also contained in fresh milk. This vitamin has been isolated in a pure state and is called ascorbic acid. Apparently the synthesis of this substance cannot take place in the body, and animals are dependent for their supply on the amounts ingested in the food. The vitamin is gradually destroyed by oxidation and therefore is not found in either stale or dried fruits, or in milk that has been heated while exposed to air.

A diet deficient in vitamin C must be taken for a period of about six months before symptoms are manifested

From these foregoing statements important practical points may be deduced the presence of vitamin C in cow's milk is dependent on the cow receiving a certain amount of fresh fodder further, the vitamin C content of the milk can be destroyed either by heating the milk or by adding an oxidising agent such as hydrogen peroxide to preserve the milk lastly more but fresh vegetables will contain the anti scorbutic factor

Morbid Anatomy—The most obvious changes are found at the end of the long bones where growth is most rapid Subperiosteal hæmorrhages are seen and the periosteum appears thickened fractures and separation of the epiphysis may be present Hæmorrhage into the swollen gums is a common finding and at times hæmorrhages may be found elsewhere notably in the skin and in the orbital cavity The bone marrow is yellow and gelatinous instead of the normal red

Clinical Features—Infantile scurvy is seen between the ages of six months and eighteen months It occurs in those who have been fed for a long period on a diet which contains no anti scorbutic factor In breast-fed children it is so rare that in these a diagnosis of scurvy should always be questioned Whilst scurvy is not a common disease it is more often seen in the better class of patient than in the hospital class this difference is due to the fact that the better class infant is more likely to be fed on the proprietary foods which do not require the addition of fresh milk An infant with scurvy presents a rather characteristic clinical picture The patient is usually thin and pallid and is obviously extremely apprehensive of being examined even to approach the cot is enough to cause crying On examination if teeth be present the gums will be swollen and red and will bleed easily In some infants this characteristic gingivitis may be the only finding Hæmorrhage into the skin is sometimes observed and hæmorrhage in the orbit more particularly into the upper lid is not uncommon The examination of the limbs is important On inspection the lower limbs are everted and slightly flexed at the hip and knee and a swelling will be observed at the lower end of the femur producing a fullness about the knee this is usually seen on both sides but at times only one limb is affected there is an absence of voluntary movement producing the scorbutic pseudo paralysis Palpation will disclose a very tender ill-defined swelling on the lower end of the femur extending from the lower end of the bone as far as half way up the shaft a similar swelling will

usually be found on the other thigh also. A striking feature of the disease is the extreme tenderness of the affected limbs and therefore palpation should be carried out with gentleness and care. At times a separation of the epiphysis is observed, caused by hæmorrhage into a joint. Similar changes may take place in the upper extremities. In some infants hæmatemesis and melæna occur. Hæmaturia, which may lead to errors in diagnosis, is often found and may be an early symptom. Pyrexia is not uncommon.

In addition to the type already described attention has been called to a latent form of this disease. Pallor fretfulness failure to gain weight, and slight tenderness of the limbs form the clinical picture, which however, is not very clear.

X rays of the bones show decrease in density, giving a 'ground glass' appearance, and the zone of provisional calcification is marked. Later the shadows of subperiosteal hæmorrhages may be seen.

Diagnosis—Many mistakes have been made from a failure to diagnose infantile scurvy. The disease is perhaps more often confused with acute rheumatism than with anything else. This error should not occur since infantile scurvy only occurs under the age of two at which age rheumatism is unknown. Scurvy has sometimes been mistaken for syphilitic epiphysitis, here again the age is of help. Syphilitic epiphysitis is a disease of early infancy, and is very rarely seen after the fifth month whilst scurvy is not seen until after that period. Osteomyelitis is sometimes the cause of difficulty, in this condition the temperature is usually high the lesion is usually limited to one area and beyond the tenderness of the bone there are no other evidences of scurvy. Pallor and hæmorrhages may suggest either leukaemia or purpura, but in these conditions there is no tenderness of bones. Trauma is to be excluded by the history. The hyperæsthetic form of anterior poliomyelitis may cause difficulty, but here the hyperæsthesia is general with no points of special tenderness. The hæmaturia may give rise to mistakes, both neoplasm of the kidney and nephritis have been erroneously diagnosed as scurvy. It may be said that scurvy will not be overlooked if the possibility of its occurrence is kept in mind.

Treatment—Few disorders in medicine respond to treatment more quickly and more completely than scurvy. Furthermore, the disease can and should be easily prevented. The daily administration of orange juice is all that is required. From the second month a start should be made with $\frac{1}{2}$ dr twice a day, and the amount should be gradually increased until by

the fourth month 1 oz a day is being taken, this amount should be continued throughout early childhood. If necessary, it may be diluted with water and a little cane sugar added. When scurvy is present, the administration of orange juice should be begun at once, amounts of several drachms at first, increasing to 1 or 2 oz within a few days. Vegetable mashes and a tablespoonful daily of a baked and mashed potato should be given if the age of the infant permits. The diet as a whole should be readjusted. If necessary, the limbs are to be splinted, and the infant should be moved as little as possible. Under this treatment recovery is rapid, the tenderness and hæmorrhages disappear in a few days, the periosteal swellings are however, absorbed much more slowly. Occasionally, after all scorbutic symptoms have disappeared, trouble is experienced with diarrhœa and vomiting, but as a rule recovery is rapid and complete.

RICKETS

Ætiology—Our knowledge of rickets has been considerably advanced by the investigations of recent years, notably those by Mellanby, Findlay, and McCollum.

In this disease the essential fault is inability of the body to lay down calcium phosphate in newly formed bone tissue, this error results in incomplete calcification, with subsequent bending and distortion of the relatively soft bone. This failure of calcification is due to an alteration of the normal proportions of calcium and phosphorus in the blood. The normal infant has 10 mg of calcium and 5 mg of phosphorus in every 100 c c of blood, in infants with active rickets the amount of calcium is normal, but the phosphorus falls below 3 mg per 100 c c of blood. At first sight it appears that the deficient calcification is due to the lowered phosphorus in the blood, but there is some evidence to show that this result is caused by an alteration of the normal proportions between calcium and phosphorus rather than to the diminution of phosphorus alone, as bone changes, apparently rachitic, may occur in conditions in which the blood phosphorus is higher than normal (renal rickets).

The diminished amount of blood phosphorus in the rachitic child is the result either of a diminished amount of a substance, vitamin D, in the diet, or the inadequate formation of this same vitamin in the body. Vitamin D is present to a variable extent in most animal fats, it is found in human milk, and is most abundant in halibut or cod liver oil, it is also formed in the skin when this is irradiated with ultra violet light.

It is only the growing child who develops rickets, and before this disease is usually seen in those infants who are fed on artificial foods containing a large amount of carbohydrates, which make for rapid growth but at the same time deficient in those animal fats which contain vitamin D. Here, when infants are fed on this kind of diet and are not exposed to any source of ultra violet light, such as ordinary light, the onset of the disease is more certain and its course is severe. While breast feeding prevents rickets, the protection it gives is by no means absolute as some infants on this diet will develop the disease.

The means by which vitamin D maintains the phosphorus content of the blood is unknown, but there is some evidence now that the absorption of both calcium and phosphorus is increased when it is administered.

Vitamin D has now been isolated, it can be produced in the laboratory by subjecting ergosterol to ultra violet rays, and it is by this means that vitamin D is formed in skin when this is exposed to ultra violet light.

Forbid Anatomy—In rickets the most characteristic changes are found in the bones. Examination of these structures by the naked eye reveals enlargement at the junction of epiphysis and diaphysis, the bone is often bent and green. Fractures are not uncommon. The periosteum is thickened by hyperemia. On longitudinal section the epiphyseal line is to be thick and irregular. These changes are most marked at the lower ends of the bones of the forearm, the lower ends of femora, and upper ends of the tibia, they are very noticeable at the costo chondral junctions of the ribs, and are found in lesser degree in every bone. Microscopical examination of the junction between epiphysis and diaphysis shows the presence of provisional calcification of the cartilage with extremely irregular penetration of the marrow capillaries in seven very irregular rows of cartilage cells. Where the capillaries have penetrated, osteoblasts have accompanied them and have laid down tissue morphologically like bone but uncalcified. This is the so called 'osteoid tissue,' which is soft and accounts for the 'enlargement of the epiphysis' of rickets.

Clinical Features—Rickets is of widespread occurrence in countries of the temperate zones. It occurs but rarely in the tropics, and then only in infants shut off from sunlight. Lack of life is a factor in the development of the disease. It occurs with great severity in dark skinned races, such as the negro and the Italian, when they attempt to live in northern

countries where there is little sun. It is much more frequent in the artificially fed than in the breast fed child.

An infant does not show evidence of rickets until the fourth month at the earliest, and the signs are most apparent between the sixth and eighteenth months. The first evidences of rickets are restlessness, irritability, and sweating of the head. The latter is very noticeable during sleep. Some time later the characteristic features are found. The child is usually well nourished but anæmic, the head is large and square, with a widely open fontanelle and bossing of the frontal and parietal bones, dentition is delayed, the thorax shows enlargement of the costo chondral junctions—the “rachitic rosary”, later, other deformities are seen, such as pigeon breast and Harrison’s groove, the latter being an indentation running transversely around the chest wall at the level of the xiphisternum, the abdomen is large and protuberant, the spleen and liver are palpable, the bones show enlargement at the epiphyses which is very noticeable at the wrists and ankles, the bones, also being soft, are bent both by muscular action and the weight of the body, the muscles are flabby and the ligaments relaxed, enabling abnormal postures to be assumed. These changes in bones, muscles, and ligaments delay the physical development of the child, and thus a child with rickets stands and walks late.

The radiographic appearances of a rachitic bone are characteristic. The shaft of the bone and the centres of ossification throw a much diminished shadow, due to the lack of calcium salts, the end of the bone is broadened and cupped and the surface irregular with a shadowy fringe hanging from it. These changes are best seen at the lower end of the radius, ulna and femur.

Complications—Infants with rickets have a lowered immunity to infections. Bronchitis and broncho pneumonia are common amongst these children, and gastro intestinal disturbances are frequent. General convulsions, carpo pedal spasm and laryngismus stridulus have a direct relation to rickets which is discussed below in the chapter on “Tetany”.

Diagnosis—As a rule rickets is easily diagnosed. The most reliable and constant sign is enlargement of the costo-chondral junctions. It must not be forgotten that these are palpable in normal infants. The square bossed head may be confounded with the globular head of hydrocephalus. The delay in walking produced by mental deficiency or a cerebral palsy may be ascribed to rickets. The history of the infant and a careful examination will usually clear up any doubts. The rachitic

spinal curvature (usually kyphotic) may be ascribed to tuberculous caries of the spine, the rachitic curve is neither angular nor painful, no reflex rigidity of muscles is found, and the deformity can be straightened out by suspension.

Lastly, there is no such disease as "scurvy rickets." An infant may, of course, develop both rickets and scurvy simultaneously, but this is very rare.

Prognosis—The prognosis in rickets is good but the liability of rachitic infants to infections is not to be overlooked. Rachitic deformities show a remarkable tendency to disappear with the passage of time.

Prevention and Treatment—Both cod liver oil and ultra violet light cure rickets, more important still is the fact that the administration of either of these two agents will prevent the onset of the disease.

In artificially fed children it is desirable to give cod liver oil from the third month, amounts of 5 minims should be given twice daily and the dose gradually increased, so that by the ninth month the infant is receiving 2 dr daily, this may be continued until the infant is eighteen months old. The few children who are unable to tolerate the oil may be exposed to ultra violet radiations or given one of the artificial preparations of vitamin D.

When the disease has developed, both cod liver oil and exposure to ultra violet light may be employed together, in order to increase the supply of vitamin D as quickly as possible.

Massage and splinting are indicated for the deformities, and iron for the anaemia so often present.

INFANTILE TETANY (*Spasmophilia*)

Ætiology—Biochemical investigations have added much to our knowledge of infantile tetany in recent years. They have shown that, in this condition there is a diminution of the calcium content of the blood, which may fall from the normal 10 mg per 100 cc of blood to a figure as low as 5 mg per 100 cc. It is known that the calcium ion exerts a sedative action on the nervous system, both central and peripheral and therefore the direct result of the lowering of the calcium is that state of hyperexcitability which is called tetany.

Theoretically, this fall in calcium may be produced in several ways: injury to the parathyroid glands, a disturbance of the acid base equilibrium in the blood, abnormal intestinal states which prevent the absorption of calcium, and lastly,

a disturbance of calcium phosphorus metabolism which occurs in rickets. It is this last condition which is responsible for tetany in the majority of infants.

Tetany, therefore, may be regarded as a complication of rickets, and this view is supported by clinical evidence in that the great majority of infants with tetany show obvious signs of rickets. Further tetany is usually seen in the spring and early summer, at the time of year, in fact, when rickets tends to heal.

Some observers have described changes in the parathyroid glands of infants suffering from tetany, and it is possible that injury to these structures may be the cause of this condition in a few cases. The influence of an alteration in the acid base balance of the blood may play a definite part, for it has been shown that the ionisation of calcium in the blood bears a relationship to the alkali reserve of the body. When this is increased the calcium ionisation is diminished, and it is only in an ionised form that the calcium exerts a sedative action on the nervous system. How great a part alterations in the acid base equilibrium of the body play in the production of infantile tetany is somewhat uncertain. Other conditions such as acute infections and hereditary predisposition, have been regarded as the cause of tetany, but probably acute infections do no more than make a latent tetany manifest. Some consider tetany to be due to poisoning with methyl guanidin, but the evidence is unconvincing.

Clinical Features—The incidence of tetany naturally follows that of rickets. It occurs in infants who are between the sixth and twenty fourth month, in premature infants, however, it may occur as early as the third or fourth month. It is rarely seen in the breast fed because rickets is uncommon in these infants.

Infants with tetany may be divided into two groups (a) those with open manifestations, and (b) those in whom the signs are latent. The latter group is the larger.

(a) The open manifestations are carpopedal spasms, general convulsions, and laryngismus stridulus.

1. **Carpopedal spasms** are tonic spasms of the hands and feet. The fingers are flexed at the metacarpophalangeal joints and the phalanges are extended over the adducted thumbs, the wrists are flexed and the hand is drawn to the ulnar side. In severe cases movement at the wrist is restricted. The feet are extended and the first phalanges of the toes are flexed. If the spasms persist for several days, oedema of the dorsal surfaces of both hands and feet may develop. Carpopedal spasm is not common.

2 General convulsions are a common manifestation of tetany. They differ in no way from convulsions due to other causes, and they can only be recognised as due to tetany by examination of the calcium content of the blood and by eliminating other causes of convulsions.

3 Laryngismus stridulus is the name given to a partial spasm of the larynx, producing a crowing sound with each inspiration, which is particularly noticeable when the child is crying. At times the spasm of the larynx is so marked as to cause complete arrest of respiration, resulting in cyanosis and occasionally in convulsions.

(b) The latent manifestations of tetany are Erb's sign, Chvostek's facial sign, and Trousseau's sign.

1 Erb's sign is a raised excitability to electrical stimulation. The test is carried out by the application of the galvanic current to the nerves. The peroneal nerve is usually chosen. The most important of the tests is the cathodal opening contraction, if this occurs with a current of less strength than 5 milliamperes it is positive evidence of tetany.

2 Chvostek's facial sign is present when contraction of the facial muscles occurs on the facial nerve being lightly tapped with the fingers midway between the zygoma and the angle of the mouth. This sign can only be relied upon when the patient is under two years of age.

3 Trousseau's sign is elicited by applying pressure to the upper arm sufficient to arrest the circulation, if the sign be present, the hand will immediately assume the typical position of carpo-pedal spasm. This sign may not be present in well marked tetany.

Diagnosis—The diagnosis of infantile tetany, particularly when convulsions only are present, may be difficult. Carpo-pedal spasm, laryngismus stridulus, and Erb's sign are pathognomonic, but these may be absent. The age limit of tetany and the usual coincident signs of rickets may enable a diagnosis of tetany to be made, and this condition should always be suspected as a cause of convulsions in an infant who is between six months and two years and has no evidence of an organic brain lesion.

Prognosis—The prognosis in latent tetany is good. In the open type, death may occur either during a convulsion or during an attack of laryngeal spasm, the prognosis should therefore be guarded. Pertussis is an exceptionally unfavourable complication of tetany.

Treatment—The treatment of infantile tetany may be considered under two headings—

1 *Treatment of Latent Tetany*—The treatment of this condition really resolves itself into treatment for the associated rickets. Adequate doses of cod liver oil are to be given and exposure to ultra violet radiations may be employed as an adjuvant. The infant's diet should be reviewed and steps be taken to alter it should this be considered necessary.

2 *Treatment of Open Tetany*—Here, in addition to the treatment outlined above, steps must be taken to treat the active manifestations. Improvement will be effected if the diet is changed from a "sweet" to an "acid" milk mixture milk with 1 dr of lactic acid (B.P.) to the pint may be used. Further there is need for the administration of calcium salts which may be given as calcium chloride, 30 to 60 gr daily administered in the food. The general convulsions should be treated with an initial dose of an aperient, followed by a short period six to twelve hours, of starvation, later, acid milk should be given with calcium chloride. It may be necessary to control the convulsions by bromides and chloral.

With active manifestations both cod liver oil and ultra violet light should be employed together in order to increase the anti rachitic factor as soon as possible.

CÆLIAC DISEASE

(Chronic Intestinal Indigestion)

Ætiology—The cause of coeliac disease is unknown. It is seen both in children who have been the subjects of long continued nutritional disturbances in infancy, and in those who have received a diet containing a disproportionate amount of fat and protein. The essential feature of the disease is intolerance of ingested fat and carbohydrate—a very small amount of these two articles of food provokes and exacerbates the symptoms.

A diminution or lack of pancreatic and intestinal ferments has been suggested as the cause of this disorder. Other observers have claimed that the condition is due to a lack of bile and still others that it is due to a chronic infection, but not one of these theories is an adequate explanation of the cause.

Morbid Anatomy—In the few examples of coeliac disease on which an autopsy has been performed, no very definite findings have been recorded. There is usually a dilatation of the intestines particularly obvious in the colon, and the intestinal mucosa is atrophied. The liver has been reported to be smaller than normal, and occasionally there has been some increase of fibrous tissue in the pancreas.

Clinical Features—Coeliac disease is seen in children between one and five years of age. It is more common in children of the upper and middle classes. The onset is insidious, with loss of weight and looseness of the bowels. The patient is undersized and underweight, there is absence of subcutaneous fat. The most striking feature is the enlargement of the abdomen, due to the pressure of an abnormal amount of gas, which results from excessive intestinal fermentation. Another factor in the enlargement is atony of the intestinal musculature, which allows distension to take place easily. The size of the abdomen is apt to vary, the day measurement being three or four inches more than that of the night. The stools are characteristic, being bulky, pale in colour, of foul odour, and often frothy, from four to five are passed during the twenty four hours. Periods of constipation may occur, but even then the stools retain their bulk, pallor, and offensiveness. There is considerable general muscular weakness, and walking may be delayed. Associated with these symptoms is a curious mental state. The children are irritable and capricious, usually they are precocious and often show a curious interest in their symptoms and may become quite hypochondriacal. At times the knee jerks may be absent, and a general but slight oedema may develop. When coeliac disease is of long standing, bone deformities may occur. These are not seen in children under the age of seven, they are apparently rachitic in nature and may be cured by the giving of ultra violet radiations if the patient is on a fat free dietary. Tetany is also an occasional complication of this disorder.

Diagnosis—The diagnosis of coeliac disease does not as a rule present difficulties. It is apt to be confused with Hirschsprung's congenital dilatation of the colon, but in this condition there are periods of prolonged constipation dating from birth, and this history enables the correct diagnosis to be made. Tuberculous peritonitis is a more frequent cause of difficulty, and in this case the correct diagnosis may only be reached after fairly long observation.

Prognosis—Children with coeliac disease rarely fail to recover, but the condition is a serious one and entails a long period of ill health. Some recover comparatively quickly with proper treatment, and in a few years will have attained normal development, in many, however, digestive difficulties will persist, and recovery will not take place until puberty is reached. Co-operation in treatment on the part of child and parents will materially hasten the rate of recovery.

Treatment—The treatment of coeliac disease is difficult and

trying to all concerned. The patient is usually spoilt and difficult to control, if possible, the services of an efficient nurse should be obtained. The essential part of the treatment is dietetic, and it is to be remembered that as intolerance of fat and carbohydrate is present, a diet must be constructed which is composed to a great extent of protein food. At first the diet should consist of buttermilk or protein milk, this should be continued until the stools are firm, the abdominal distension is slight, and the appetite good. This stage is usually reached in a few days. Then almost pure protein foods are added, such as curds, minced meats, gelatine and white of egg. Later the whole egg may be taken. In this second stage bananas are undoubtedly of much value, one may be given at the end of the first week, and the supply may be increased by one daily until four to six are taken. As a rule, this addition to the diet is welcomed. When the patient is apparently progressing on this diet the addition of carbohydrates must be made, but great caution is to be exercised. Preparations of dextrin and maltose may be given, beginning with 1 dr a day and gradually increasing to 2 oz, later, vegetables may be added and the diet gradually built up. Bread, cereal foods and potatoes are the last to be allowed. If carbohydrates are allowed too freely and too quickly a relapse will almost certainly occur, and a new start may have to be made. In dieting these children the vitamin supply must not be overlooked, orange juice may be given from the commencement of treatment, and non fatty preparations containing vitamin D are to be included.

Relapses are common and disheartening and will call for a restriction of the diet. In the early stages of treatment these patients are best in bed. For the anaemia iron is indicated. Ultra violet radiation is often of benefit.

CYCLIC VOMITING

Ætiology—The cause of cyclic vomiting is unknown. It occurs in the highly strung active child and is very apt to follow some unusual excitement such as a children's party or some unwanted fatigue such as a railway journey, again, in children liable to this condition it is seen as a complication of a minor illness such as tonsillitis. It is the nervous child that suffers from cyclic vomiting and often one or other of the parents will have suffered from the same condition in childhood.

There is evidence to indicate that cyclic vomiting is a disturbance of metabolism. During the attack large amounts of ketone bodies are excreted in the urine, and the amount of sugar in the blood has been shown to be lower than normal. The significance of these findings is doubtful, but it has been suggested that these patients metabolise fats less easily than normal children, because they are unable to draw upon the carbohydrate reserves in their bodies to oxidise all of the ingested fats. By this hypothesis the low blood sugar and ketonuria are explained, the low blood sugar is however, by no means a constant finding and one is perhaps not justified, according to present knowledge, in saying more than that cyclic vomiting is due to some fault in metabolism.

Clinical Features—Cyclic vomiting usually begins between the ages of two and four, but it may occur in infancy. The type of child in whom it occurs has already been outlined. It is more often seen in private than in hospital practice.

The attacks of vomiting occur at variable intervals—as often as once a week, as infrequently as once in six months, the actual attack lasts usually about three days. Often there are prodromata, languor, headache, anorexia, and abdominal discomfort, which last for twenty-four hours, then the vomiting begins and overshadows everything else. It occurs after anything ingested, and continues both day and night at frequent intervals, often every half hour or so. The temperature is often a little raised, up to 100°F , thirst is excessive but any attempt to satisfy it provokes the vomiting anew, the bowels are confined, the little urine that is passed is highly concentrated and contains ketone bodies.

Some hours after the onset in severe cases, signs of exhaustion begin to appear, the pulse becomes rapid, the eyes sunken, the complexion of an ashy grey colour, and the patient may appear to be at the point of death. On examination there may be slight epigastric tenderness due to the repeated vomiting, the abdomen as a whole is swollen. About the third day the intervals between the attacks of vomiting lengthen, some fluid may be retained, and then the vomiting ceases. Convalescence from the attack is very rapid, and in a few days the patient is up and about.

Diagnosis—The diagnosis of cyclic vomiting is usually not difficult, for the history of previous attacks leads, as a rule, to the correct interpretation of the symptoms. The first attack, however, may cause difficulty, and may suggest the onset of meningitis. Other conditions, such as acute gastritis, intussusception, and appendicitis, causing vomiting must not be

overlooked. Further, organic disease of the brain or kidneys has to be excluded by careful examination. In children who are the subjects of this disorder, care must be taken not to assume that the symptoms present are due to an attack of cyclic vomiting without excluding other conditions.

Prognosis—The prognosis in cyclic vomiting is good. Although often patients appear to be desperately ill, recovery is the rule. There are, however, a few fatal cases on record. Attacks usually cease at puberty, occasionally attacks of migraine may take their place.

Treatment—The treatment may be considered in two divisions—

1 *During an Attack*—Once the vomiting has commenced nothing seems to be able to control it. An attempt may be made to give small amounts of a solution of 10 per cent glucose with 10 gr of sodium bicarbonate in water by mouth every two hours, but usually this only provokes the vomiting anew.

Benefit is obtained by rectal injections of 5 to 6 oz of 5 per cent glucose and saline solution with $\frac{1}{2}$ dr of sodium bicarbonate if they can be retained. If collapse is very severe subcutaneous saline may be necessary.

When the vomiting begins to abate, food in small quantities in a liquid form may be given.

2 *Between Attacks*—All forms of excitement are to be avoided. The fats in the diet should be much restricted, it is often advisable to give the milk skimmed. Considerable benefit will be obtained by giving 15 to 30 gr of sodium bicarbonate three times a day after food for a long period. Liquid glucose should also be administered in dessertspoonful doses three times a day after meals. A weekly mercurial purge is advisable.

Prodromata should be treated with a brisk purge and drachm doses of liquid glucose every hour.

CONVULSIONS IN INFANTS AND YOUNG CHILDREN

Ætiology—Convulsions are common in infancy and early childhood. The primary cause of the increased liability at this period of life is generally ascribed to an instability of the infantile brain, consequent on its immaturity. The secondary causes acting on this unstable mass of nerve tissue are various and some of them are unknown, but it is by means of these secondary causes that it is possible to divide

convulsions into three groups. Firstly, symptomatic convulsions which are due to obvious organic changes in the brain or its membranes; secondly, toxic convulsions resulting from morbid changes in other parts of the body or alterations in the body fluids; thirdly, functional convulsions of unknown origin and accompanied by no apparent alteration of structure.

The first group includes convulsions due to hæmorrhage into the brain or meninges caused by the transit of the head through the maternal passages at birth; in this group also are placed the convulsions caused by the different varieties of meningitis, by intracranial tumours, by polio-encephalitis, and those associated with maldevelopment, or degenerative processes of the brain.

The second group includes convulsions due to tetany; those seen at the onset of the acute specific fevers and of other infections such as pneumonia; convulsions due to uræmia and lead-poisoning; and, lastly, those seen in states of asphyxia.

In the third group are placed those convulsions which have no apparent cause. In this group are included those children who are said to have epilepsy.

Morbid Anatomy.—In infants with convulsions which are either symptomatic or toxic, the findings at autopsy will naturally depend on the immediate exciting cause. In infants who have died from functional convulsions the only findings are punctate hæmorrhages scattered throughout the brain, with distension of the right side of the heart and congestion of the lungs.

Clinical Features.—A convulsion begins with pallor, slight twitching of the facial muscles, and fixation of the eyes; after a few moments the muscular twitchings spread over the body and become more marked, the head is thrown back, the hands are clenched; then definite clonic movements of the extremities appear. Slight cyanosis is seen, consciousness is lost, and there is often some slight frothing at the mouth. The breathing is shallow, the pulse is weak, and the bladder and rectum may be emptied. The convulsive movements vary in intensity; at times they are very striking. They are usually bilateral and synchronous, but occasionally one side of the body is alone affected. The seizure is very variable in duration, lasting for a few moments or as long as half an hour; at the end of it the patient is left stuporous. Paralysis of a transient character are sometimes seen after the attack, and prostration is constant. A convulsion is apt to be followed by others in the few days succeeding it.

Diagnosis—The recognition of a convulsion is usually easy but the determination of the exciting cause is often difficult. A consideration of the patient's age is important. During the first three months of life, and more particularly in the few weeks immediately subsequent to birth, convulsions are usually due to hæmorrhage or injury sustained during birth, from six to eighteen months of age tetany is by far the most common cause, after the age of two, recurrent convulsions in an otherwise apparently healthy child may be epileptic.

It is important to realise that, should fever be present a convulsion may herald the onset of an acute infection, either of the central nervous system or elsewhere in the body.

Convulsions associated with defective cerebral development are recognised by the presence of evidence of mental deficiency when they are caused by cerebral tumours, or associated with cerebral palsies, definite physical signs, indicative of disease of the central nervous system, will be found on examination. It must be borne in mind that uræmia is a possible cause of convulsions. In the terminal stages of other illnesses, convulsions are usually caused by asphyxia.

Prognosis—The prognosis depends to a great extent on the exciting cause of the convulsion, and will therefore differ accordingly. The convulsion itself, unless prolonged and recurrent or occurring as a terminal event in some other illness is rarely fatal. In addition to the immediate outlook the remote prospect is to be considered. Convulsions due to organic causes usually persist, but those due to tetany clear up as a rule and leave no trace. With repeated convulsions in children over the age of two, the possibility of epilepsy is always to be considered.

Treatment—During a convulsion, the time honoured treatment of immersing the infant in a mustard bath is of value. If the attack still persists, the administration of chloroform will have an immediate effect. To prevent a recurrence chloral is to be given. The dose at six months is 4 gr. and it should be injected through a catheter high into the bowel. This may be repeated in an hour, if necessary. In addition bromides may be given by the mouth. 5 gr. of sodium bromide being a suitable dose for an infant of six months.

Once the attack has been controlled search is to be made for the exciting cause, and this must be treated, if possible.

A. G. MAITLAND-JONES

DISEASES DUE TO PHYSICAL AGENTS, POISONINGS, AND INTOXICATIONS

SEA-SICKNESS

UNPLEASANT symptoms, which include nausea, vomiting, giddiness, headache and diplopia, may occur as the result of unaccustomed motion either on the sea or in the air, or even in a train or motor car. Common though the condition is, there is still no agreement as to its etiology and it is variously attributed to labyrinthine or ocular disturbances, acidosis, or even hysteria. Sea-sickness is rare in infants and the aged and it is specially common in those subject to migraine and cyclical vomiting.

The symptoms of sea sickness are unfortunately too familiar to need description, but it is important not to overlook more serious conditions, such as appendicitis or perforation.

Treatment—Susceptible persons should take a good meal with plenty of carbohydrate and strictly limited fat an hour or two before embarking. During the voyage glucose (1 oz. in a glass of orangeade) should be taken at frequent intervals, in order to avoid ketosis. Sedative drugs are valuable, particularly chloroform, which may be taken in 5 grain doses in cachet form. Phenobarbitone (1 gr. t.i.d.) is also sometimes beneficial. Subjects of sea sickness should remain recumbent in a warm ventilated cabin, situated, if possible, amidships.

CAISSON DISEASE

The term caisson disease has been applied to the clinical syndrome which may result from too rapid decompression after exposure to a high atmospheric pressure, such as may be required in a caisson or a diving helmet. During the period in which a worker is exposed to a high pressure, the increased partial pressure of nitrogen results in an excess of this gas going into

solution in the fluids and tissues of the body. If the pressure falls quickly the excess of nitrogen is released as bubbles of gas which may form in any part of the body, but particularly in the central nervous system. If, however, the pressure is allowed to fall gradually, the liberated nitrogen can be absorbed into the blood and excreted through the lungs.

Similar symptoms may develop with ascent to high altitudes, in aeroplanes, a man may go to 18,000 ft ($=\frac{1}{2}$ atmospheric pressure) and stay at this height indefinitely without risk of bubble formation, but if the altitude is 30,000 ft ($=\frac{1}{3}$ atmospheric pressure) most men show symptoms within one hour.

The symptoms of caisson disease will depend on the localisation of the bubbles of nitrogen and on their size. When occurring in the subcutaneous fat or in the muscles, the bubbles produce acute local pain, in the alimentary tract, passage of nitrogen from the tissues into the lumen of the gut leads to distension abdominal pain, and vomiting. Serious symptoms result from liberation of gas in the central nervous system. The lower dorsal segments of the spinal cord are most frequently affected and a paraplegia, transient or permanent, results. In severe cases the patient may die very rapidly as the result of nitrogen being liberated in the blood in large quantities.

Caisson disease may be prevented by gradual decompression. No matter how great the degree of compression, nor for how long it has been operating, a man may with complete safety be immediately decompressed to half the maximum compression value. Thus a man working at 6 atmospheres may be quickly decompressed to 3 atmospheres, he must then wait at that pressure for a time dependent on the duration of exposure to high pressure.

Symptoms do not usually occur until half an hour or more after decompression is complete. The patient must immediately be again exposed to the same increased pressure as that under which he had been working. This results in the reabsorption of the nitrogen, and decompression may then be allowed to take place extremely slowly. Symptoms usually disappear rapidly, but occasionally a permanent paraplegia remains. Fat is able to absorb relatively more nitrogen than other tissues and it is therefore advisable to forbid the obese to work under high pressures.

ANOXIA

Low atmospheric pressure such as is experienced by mountaineers, or more often in aeroplanes at a high altitude, involves

a lowered partial pressure of oxygen in the inspired air. At heights of 12,000 ft or over, symptoms due to lack of oxygen become apparent, more particularly on exertion. Although the depth of respiration is increased there is little sensation of being short of breath. The intellectual faculties are dulled and sensory perception impaired. There is often marked drowsiness and lethargy, in some subjects euphoria or irritability may be prominent features. With more extreme anoxia, such as occurs in an aeroplane at 20,000 ft or over there is great loss of muscular power which may amount to complete paralysis and unconsciousness or death may supervene. If oxygen is administered recovery is rapid and there is often complete amnesia. The onset of symptoms is insidious, and usually the subject is completely unaware that anything is wrong. Hence anoxia is most dangerous in a pilot of an aircraft, particularly in war, and it is essential that adequate oxygen should be taken early enough to prevent the onset of symptoms.

Residence at high altitudes results in an increase both in the red cell count and the hemoglobin content of the blood.

HEAT-STROKE

Exposure to the sun may produce headache, dizziness, vomiting and sometimes fainting attacks. Such symptoms have been termed heat exhaustion.

In the tropics heat stroke is prone to occur. Exposure to the sun's rays is not necessary, in fact the majority of cases occur while the patient is indoors. A moist heat, unsuitable clothing, and lack of ventilation are factors in its production.

Healthy persons rarely develop heat stroke. Most cases occur among those who are either actually already ill from some febrile disease or whose general health is poor as the result of alcoholic excess or other factors.

The onset of symptoms is usually sudden, when heat stroke occurs in a patient suffering from a pyrexial disease such as malaria, coma may be almost the first symptom. Sometimes there is a prodromal period of restlessness, vertigo and vomiting, there is a complete cessation of sweating and frequency of micturition is often an early symptom. The rectal temperature rises rapidly and may reach 110 °F. The patient becomes comatose, incontinent and convulsed, the skin feels burning hot and is congested or cyanotic. Death may occur within a few hours with cardiac and respiratory failure. If the patient survives, the temperature often remains slightly

melting of metals accumulator manufacturing and ship wrecking show the highest incidence of lead poisoning. Apart from such occupational risks occasionally cases arise from the continued ingestion of a soft drinking water that has stood in lead pipes or cisterns.

As with all other poisons, there is considerable variation in susceptibility. Even in specially dangerous occupations the number of workers who develop signs of lead poisoning is only a small proportion of the total employed and there can be no doubt that some are specially liable to lead poisoning while others are relatively immune. On the other hand, certain factors undoubtedly predispose to the disease. Perhaps the chief of these is chronic alcoholism; while renal disease, gout, anemia and malnutrition all render persons exposed to lead absorption specially liable to develop poisoning. Another very important precipitating factor is the occurrence of an acute infection such as influenza or pneumonia. After such an illness, exposure to lead should be avoided for at least a month. Women are rather more susceptible than men and the young more susceptible than the mature.

Lead is mainly excreted into the colon and may be found in the faeces, whether the metal is swallowed or inhaled. To a less extent excretion takes place through the kidneys. Those who have worked for a long period in occupations which deal with lead often appear to reach a condition of equilibrium in which the excretion of the metal keeps pace with its absorption and they never show any actual evidence of poisoning.

ACUTE LEAD POISONING—This usually results from the swallowing of a large quantity of a soluble lead salt such as the acetate. There is a burning taste in the mouth and acute abdominal pain accompanied by vomiting and diarrhoea. The blood pressure falls and signs of collapse develop. Death may occur within a few days but frequently the patient survives and shows symptoms of chronic lead poisoning.

If seen within a few hours of swallowing the poison the stomach should be washed out with dilute hydrogen sulphide water slightly acidulated with sulphuric acid, as this tends to render the lead less soluble. Sodium or magnesium sulphate should be given in $\frac{1}{2}$ oz. doses in order to aid elimination from the bowel.

CHRONIC LEAD POISONING—Early diagnosis is of the greatest importance. Among the early symptoms of plumbism are the following any of which, should they occur in a person exposed to lead must arouse suspicion—

1 *Pallor*—The conjunctive may not appear obviously

elevated for some days. During convalescence peristaltic headache and mental disturbances may occur.

Treatment.—The results are often dramatic. Within half an hour the patient, previously cyanosed and convulsed, may be restored to practically a normal condition. The temperature must be reduced as rapidly as possible to about 102° F. To save life, treatment must be both vigorous and immediate. Stripped naked, the patient is laid on an iron bedstead covered with matting permeable to air; he is then sprayed with cold water and kept under a fan; the rectal temperature is taken at five minute intervals as it is important to cease active treatment as soon as it falls to between 102° and 103° F. When the pyrexia has fallen sufficiently, the patient is put to bed and carefully watched for a recurrence of hyperpyrexia. For collapse, hot water bottles should be applied. Consciousness is usually regained very rapidly as the temperature falls. In every case in which malaria is a possible factor, an immediate dose of 10 gr. of quinine bishydrochloride should be given intravenously. When there is much congestion, venesection is beneficial. Violent convulsions may necessitate induction of light anaesthesia. When sufficiently recovered to travel the patient should be removed to a cooler climate owing to danger of relapse.

The prophylaxis of heat-stroke is most important. Suitable clothes, open at the neck, a pith helmet, and sun goggles are all important. An ample supply of cold drinking water should always be available, and should be taken freely to counteract the loss of fluid due to sweating. Alcohol should be avoided until sunset, and the midday meal should be small.

LEAD POISONING

Lead may be absorbed through the lungs or through the alimentary tract. Research into occupational lead poisoning and experimental evidence point to the fact that the inhalation of dust containing lead is a more potent cause of poisoning than absorption through the digestive tract. Experimental work has shown that symptoms of poisoning appear more rapidly and with smaller doses of lead if the method of inhalation rather than that of ingestion is employed. Specially dangerous occupations are those in which the workers are subjected to fumes from molten lead, or where they are exposed to the inhalation of air laden with dusty lead compounds (e.g., lead carbonate or lead oxide). Occupations such as white lead manufacture

smelting of metals, accumulator manufacturing and ship breaking show the highest incidence of lead poisoning. Apart from such occupational risks, occasionally cases arise from the continued ingestion of a soft drinking water that has stood in lead pipes or cisterns.

As with all other poisons, there is considerable variation in susceptibility. Even in specially dangerous occupations the number of workers who develop signs of lead poisoning is only a small proportion of the total employed and there can be no doubt that some are specially liable to lead poisoning while others are relatively immune. On the other hand, certain factors undoubtedly predispose to the disease. Perhaps the chief of these is chronic alcoholism, while renal disease, gout, anaemia, and malnutrition all render persons exposed to lead absorption specially liable to develop poisoning. Another very important precipitating factor is the occurrence of an acute infection such as influenza or pneumonia. After such an illness exposure to lead should be avoided for at least a month. Women are rather more susceptible than men, and the young more susceptible than the mature.

Lead is mainly excreted into the colon and may be found in the faeces, whether the metal is swallowed or inhaled. To a less extent excretion takes place through the kidneys. Those who have worked for a long period in occupations which deal with lead often appear to reach a condition of equilibrium in which the excretion of the metal keeps pace with its absorption, and they never show any actual evidence of poisoning.

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CHRONIC LEAD POISONING—Early diagnosis is of the greatest importance. Among the early symptoms of plumbism are the following, any of which, should they occur in a person exposed to lead, must arouse suspicion—

1 *Pallor*—The conjunctivæ may not appear obviously

anæmic, and the hæmoglobin may be but little below normal. The pallor is of an ashen hue, and it has been suggested that this is due to the action of lead on the skin capillaries.

Anæmia of varying degree is common in lead poisoning. The hæmoglobin percentage is 70 or below, and the colour index is low. Basophil granules are seen in many of the red cells, a condition described as *punctate basophilia*. Although this is also found in other forms of anæmia, it is rarely seen to such a striking extent as in cases of lead poisoning. Its occurrence in a lead worker, even in the absence of other signs, is a valuable indication that lead absorption is occurring.

2 *Blue Line*.—In the presence of oral sepsis the well known "blue line" appears near the gum margin. On careful examination with a lens the line is seen to consist of a large number of discrete granules of dark colour deposited deeply in the tissues. It is usually less than 1 mm. in width, and is specially obvious where oral sepsis is most marked. It does not occur at the exact point where the gum is adherent to the teeth, but is separated slightly from the gum margin. Care must be taken to differentiate the bluish coloration seen in pyorrhœa alveolaris from the blue line of plumbism. This is due to the formation of lead sulphide in the gums. It is produced by the action of sulphuretted hydrogen derived from decomposition processes in the debris of protein food around septic teeth, on circulating lead. No blue line is seen if the mouth is edentulous and cure of the teeth reduces the liability to its occurrence. It must, however, be clearly understood that a blue line is nothing more than an index of recent lead absorption. Some lead workers have a blue line for months and would appear to be little the worse for it, while occasionally cases of obvious lead poisoning show no line. A somewhat similar "blue line" also occurs following the taking of bismuth, and is sometimes seen when this metal is used in the treatment of syphilis.

3 *Loss of Weight*.—This is due to a loss of subcutaneous fat, and to a less extent to wasting of the muscles.

4 *Abdominal Symptoms*.—Apart from lead colic, vague gastric symptoms, anorexia and particularly constipation are common in all stages of plumbism.

5 *Early Mental Changes*.—Mental lethargy and drowsiness are not uncommon in the early stages of lead poisoning. In other cases the patient is restive and irritable. He may complain of slight headache and of extreme fatigue.

6 *"Rheumatic" Symptoms*.—Vague pains in the muscles

and around the joints, which are usually described as chronic rheumatism or lumbago, occasionally occur

7 *Neurological Symptoms*—A fine tremor of the out stretched fingers, sometimes with formication and numbness, may occur early. It is often possible by careful examination to detect some slight weakness of the extensor muscles, especially of the ring and little fingers, many months before the typical wrist drop appears

Symptoms such as those described above may persist for long periods without producing serious disability. At any time, however, such patients are liable to display additional and more serious symptoms, the so called "Toxic episodes". These are colic, palsy, encephalopathy, and ocular disturbances. Of these colic and palsy are by far the most common, colic occurring in practically every case and palsy in about 10 per cent of cases

1 *Lead Colic*—The patient complains of severe abdominal pain, which is usually referred to the lower abdomen. Obstinate constipation and anorexia are also present. During the attacks of colic the pulse is slow and the temperature subnormal, firm pressure on the abdomen tends to relieve rather than to increase the pain. There is no rigidity, but sometimes firm tumours consisting of contracted intestine may be felt. Occasionally, difficulty may arise in differentiating the case from acute abdominal conditions

2 *Lead Palsy and Encephalopathy*—These are described elsewhere (*vide p 940*)

3 *Ocular Disturbances*—Toxic amblyopia with temporary blindness, but without obvious retinal changes, may occur. Peripheral neuritis involving the oculomotor nerves may produce diplopia

4 *Sequelæ*—Some doubt has recently been expressed, particularly by American workers, concerning the time honoured statement that chronic lead poisoning produces arteriosclerosis and chronic nephritis. Much of the evidence on this point is contradictory but the excellent work of Nye in Australia (*vide p 717*) has shown beyond any doubt that, in children at any rate, chronic lead poisoning may lead to severe renal damage of the diffuse vascular sclerotic type. In women, plumbism often produces abortion, while in males there may be sterility

Differential Diagnosis—Failure to diagnose lead poisoning is more frequently due to lack of care in history taking and in examination rather than to any inherent difficulties in the interpretation of symptoms. As a rule the occupation of the

patient will suggest the diagnosis, but it must be remembered that abdominal symptoms in lead workers are not necessarily due to lead poisoning.

Prophylaxis and Treatment—Industrial lead poisoning is notifiable in Great Britain to the Home Office. Its incidence has fallen as the result of preventive measures from 1038 notified cases in 1900 to 96 in 1938. It is therefore at the present time a relatively rare disease.

The methods adopted for the prevention of lead poisoning fall under three main headings: (a) the avoidance of the ingestion of lead by the mouth, (b) adequate ventilation of workshops, (c) periodical medical examination of lead workers. The first of these can be attained by adequate provision of lavatory accommodation and dining rooms for workers. The second is unfortunately a more difficult problem, in many occupations lead fumes and dusty lead compounds are inevitable but the provision of local exhaust fans or the use of respirators may help to diminish their inhalation. As regards periodical medical examination all lead workers should be examined at least once a month, special attention must be directed to the detection of loss of weight, constipation, a blue line on the gums, anaemia, and weakness of the extensor muscles of the upper limbs.

When lead poisoning has developed, the first essential in treatment is the removal of the patient from the work in which the disease has been contracted. In mild cases this is sufficient. In all cases of fully developed poisoning a permanent change of occupation becomes necessary, as otherwise, relapse is certain to occur. Attention must be paid to the general hygiene of the patient particularly as regards open air and sunshine and the condition of the teeth and gums. Constipation is almost invariable, and is best treated by full doses of magnesium or sodium sulphate.

It has been shown that following lead absorption the metal is for the most part stored in the bones and during the active stages of lead poisoning an attempt should be made to prevent the mobilisation of the poison from such storage. This may be effected by giving a pint of milk daily together with a vegetarian diet. Only after all acute symptoms have passed off should an attempt be made to promote the elimination of lead. Potassium iodide has for nearly a century been credited with the power of aiding the elimination of lead. It is best given in small doses, not more than 5 gr. thrice daily at the beginning of treatment, as occasionally it appears to produce a temporary aggravation of symptoms. A far more effective

method is to prescribe a calcium free diet and further to assist elimination by producing an acidosis by giving ammonium chloride (20 gr in capsules t d s) This de leading treatment should be continued for some four weeks

In cases of colic, hot applications to the abdomen give some relief, and the patient may be given an inhalation of amyl nitrite or $\frac{1}{16}$ gr of atropine hypodermically The administration of calcium gluconate is even more effective 10 c c of a 20 per cent solution may be given intravenously This usually rapidly eases the acute pain The constipation must be relieved, and for this purpose enemata are often required For lead palsy the wrists should be kept at rest on splints in a position of dorsiflexion, and massage and electrical treatment should be employed In cases of encephalopathy, sedatives are often necessary, such as bromides and chloral, and calcium gluconate may be given intravenously, in comatose patients, or those with convulsions, venesections or lumbar puncture are occasionally beneficial For the anæmia the most useful measures are fresh air, plenty of fresh fruit and green vegetables, together with the administration of iron

ARSENICAL POISONING

Arsenic was for long one of the most popular poisons employed by murderers but at the present time it is in disrepute owing to the ease with which it can be recovered from the body of the victim even long after death Arsenical poisoning still occasionally occurs as an occupational disease and as the drug is often employed as a poison for vermin and insects, accidental poisoning is sometimes encountered Epidemics of poisoning have occurred from contamination of food by arsenic, perhaps the best known instance of this was that due to beer made with contaminated glucose, which occurred in Manchester in 1891 Strict regulations limiting the amount of arsenic in foods and beverages have completely abolished poisoning from this cause At the present time the majority of cases of arsenical poisoning arise from prolonged medical treatment with arsenic

Acute Arsenical Poisoning—The most prominent symptoms are intense abdominal pain, diarrhoea, and collapse and death may occur within a few hours The stomach must be washed out and a solution of ferric hydrate introduced Intravenous saline and morphia may be necessary

Chronic Arsenical Poisoning—This results from long continued small doses of arsenic The two most characteristic

features are peripheral neuritis and changes in the skin. The neuritis, like that produced by alcohol, affects the legs rather than the arms, sensory symptoms are more prominent in arsenical neuritis, and numbness and pain in the legs are commoner than in alcoholism.

There is a brown pigmentation of the skin, which is specially marked in the flexures. The soles and palms show great thickening of the epidermis and appear dry and scaly, a condition known as hyperkeratosis. Unlike Addison's disease, arsenic does not produce pigmentation in the mouth.

Anæmia of a secondary type occurs in severe cases and there may be anorexia, gastric disturbances, and a tendency to attacks of diarrhœa.

The diagnosis in patients who are known to be taking arsenic is usually easy. Confirmation is obtained by the discovery of arsenic in the urine, feces, or hair. There is no specific treatment. Naturally the absorption of arsenic must be stopped and elimination promoted by keeping the bowels freely open.

Poisoning by Salvarsan and Allied Arsenical Compounds is described elsewhere (*vide p. 165*).

MERCURIAL POISONING

Mercurial poisoning is rare as an occupational disease, and in its acute form mainly occurs in attempted suicide. Medicinal treatment with mercury may lead to symptoms of poisoning.

Acute Mercurial Poisoning—Rapid onset of abdominal pain and vomiting is followed by a hæmorrhagic diarrhœa. There is a metallic taste in the mouth, with profuse salivation. The kidneys are affected early, and anuria or uremia supervenes.

Immediate treatment consists in washing out the stomach and the introduction of the whites of four eggs in a pint of milk, with a view to the formation of an insoluble mercury albuminate. Collapse is treated by warmth and stimulants, but when the pain is acute morphia is required.

Chronic Mercurial Poisoning—Pallor, loss of weight, head aches and indigestion are early symptoms of mercurial absorption. The most characteristic features of chronic poisoning are stomatitis and gingivitis with excessive salivation, albuminuria and muscular tremors. The diagnosis can be confirmed by the finding of mercury in the urine.

Treatment consists in preventing the absorption of further mercury and promoting elimination through the bowels with saline purgatives

CARBON MONOXIDE POISONING

Carbon monoxide (CO) poisoning may result from the inhalation of coal gas or the exhaust of petrol engines. While usually suicidal in origin, accidental poisoning is not uncommon. The poisonous effects of carbon monoxide are due partly to a specific toxic effect on the tissues, partly to anoxæmia, as the gas forms a stable combination with hæmoglobin, known as carboxy hæmoglobin, thereby paralysing the action of hæmoglobin as an oxygen carrier.

If the concentration of carbon monoxide in the inspired air is $\frac{1}{2}$ to 1 per cent, death may occur within a few minutes. When the concentration of the gas is small, preliminary symptoms of headache, giddiness, and confusion arise, which may closely simulate alcoholism. With higher concentrations the patient rapidly becomes comatose and convulsed. Owing to the formation of carboxy hæmoglobin the blood, skin, and mucous membranes are cherry red in colour. Sometimes the patient may die suddenly of heart failure, particularly if the gassed patient exerts himself.

Prolonged exposure to carbon monoxide in low concentrations may produce chronic poisoning, and the patient may have fainting attacks, loss of power on exertion, headache, nausea, palpitation, or neuritis.

Prophylaxis and Treatment — Canaries are extremely susceptible to very small amounts of the gas. When gas is suspected, as in mine shafts or caves, a canary is taken down, and so long as it remains unaffected the atmosphere may be regarded as safe.

In the treatment of carbon monoxide poisoning it is important to give oxygen to which 7 per cent of carbon dioxide has been added. The latter stimulates the respiratory system and produces increased pulmonary ventilation. In severe cases an oxygen tent should be used. If the patient has ceased to breathe, immediate artificial respiration must be performed. This should be continued for at least three hours before giving the case up as hopeless. The tongue should be held forward and a free airway ensured. Venesection followed by blood transfusion may increase the oxygen carrying power of the blood.

FOOD POISONING

A considerable proportion of the diseases to which man is subject are the result of eating infected or poisonous food, and were the term food poisoning taken in its widest sense it would include many maladies such as cholera, typhoid, dysentery and some forms of tuberculosis. Food poisoning, however, has come to be used in a more restricted sense, and includes only certain types of gastro intestinal infections and the results of ingesting poisonous substances such as certain fungi. Formerly the term ptomaine poisoning was used synonymously with food poisoning, owing to the idea that the symptoms produced by contaminated food were due to ptomaines, organic bodies resulting from the breakdown of protein. Ptomaine poisoning as a medical term is going out of use, as it is now realised that the decomposition products of food contaminated by non pathogenic organisms are seldom injurious to man.

Food poisoning may be classified into two main groups of cases. (1) poisoning due to chemical bodies, as, for example, in certain fungi and fruits, (2) infection of food by certain pathogenic organisms, which may produce toxins in the food before it is eaten, or may multiply within the body.

Food poisoning of the first group is relatively uncommon and usually results from eating poisonous fungi in mistake for mushrooms. Soon after ingestion of the poisonous material vomiting, diarrhoea and collapse occur. The liver is often affected, and a condition resembling acute yellow atrophy supervenes with a fatal result.

Far more important however, is food poisoning due to the infection of food by pathogenic organisms, particularly *B. cereus*, *B. enteritidis* of Gaertner, and *B. dysenteriae* Sonne.

Contamination of food depends on a number of factors. One of the most important of these is the climate. In hot countries food poisoning is notoriously common owing to the fact that micro-organisms can multiply rapidly, and also because the food is more liable to become infected by flies. Lack of care in the preparation and storage of food will increase the danger of food poisoning, as will also the length of time during which food is kept before consumption. Food poisoning is often supposed to be associated with the use of canned food particularly meat and fish. With modern methods of sterilisation in the canning industry the risk is negligible.

Food Infection by the *Bacillus Dysenteriae* Sonne. *B. dysenteriae* Sonne is frequently the cause of localised outbreaks

of diarrhoea and vomiting in adults and of summer diarrhoea in children

The clinical course varies greatly in the majority diarrhoea and vomiting are associated with moderate fever of some twenty four to forty eight hours' duration Others have milder symptoms for some weeks In infants and children, collapse and prostration may be severe and death—very occasionally sudden—take place A simple fluid diet with rest in bed is usually all that is required The organism quickly dies out in the majority of cases Personal hygiene is essential to prevent the spread of infection and in institutional epidemics search should be made for a carrier

Food Infection by the Gaertner Bacillus and Allied Organisms—The symptoms vary considerably in severity, ranging from a mild attack of vomiting and diarrhoea to a condition of profound and sometimes fatal collapse The virulence of the organism, the amount of contaminated food eaten and the reaction of the individual are all important factors in determining the course of the illness

The onset of symptoms is usually within a few hours of the ingestion of the infected material The earliest to appear are dizziness and abdominal pain of a colicky character, nausea and vomiting occur early, and later there is diarrhoea with the passage of watery stools In mild cases when the infected food has been got rid of by vomiting or diarrhoea the patient rapidly recovers In severe cases however, there are grave constitutional symptoms After a few hours there is some degree of pyrexia and the repeated vomiting and diarrhoea produce a condition of tissue dehydration which may resemble cholera As in the latter disease, the stools are rice water in type with no fecal material rarely blood and mucus may be passed, suggesting bacillary dysentery The facies becomes pinched and the eyes sunken, severe cramps, as in cholera occur in the calves, the urinary flow is diminished owing to dehydration, and eventually the patient may die of cardiac failure Needless to say, all grades of severity occur between the very mild and very severe choleraic forms of the disease

A diagnosis of food poisoning should not be made without a careful physical examination to exclude appendicitis and other abdominal conditions Frequently the occurrence of symptoms among a number of people who have partaken of the same food will give a clue to the diagnosis, but it must be remembered that individuals vary greatly in their susceptibility to food poisoning, and therefore not every one who has eaten infected food need necessarily show symptoms Those who have

previously suffered from dysentery or colitis are specially susceptible

The treatment will vary with the severity of the illness. Confinement to bed is advisable during the acute stage. In mild cases castor oil ($\frac{1}{2}$ to 1 oz.) should be given together with 25 minims of tincture of opium. Kriolin ($\frac{1}{2}$ to 1 oz.) is often of great value. A hot water bottle on the abdomen usually relieves the colic. Nothing should be given by mouth except water or albumen water with a little glucose. In severe cases with dehydration and collapse purgatives may be dangerous. The first essential is to restore the fluid content of the body, and this may be done by rectal saline. If the latter cannot be retained intravenous saline may be necessary. In severe cases convalescence is slow and the patient may develop a chronic gastritis which may need careful dietetic treatment for many months. In mild cases, when the acute symptoms disappear, rapid return to a normal diet is possible.

Botulism—This exceedingly rare disease is due to the toxins of *Clostridium botulinum*, an anaerobic spore forming bacillus contaminating tinned food. The symptoms resemble those of an encephalitis rather than food poisoning. The prominent features are diplopia, ptosis and failure of accommodation, progressive muscular weakness, constipation and respiratory failure.

Treatment usually ineffective consists in immediate administration of antitoxic serum (obtainable from the Ministry of Health), some form of respirator apparatus and small doses of morphine.

Food Idiosyncrasies—Hypersensitiveness to the protein in certain kinds of food is not uncommon. Such articles of food as shell fish, milk, eggs, and strawberries may in certain individuals produce urticarial rashes and sometimes attacks of diarrhoea and vomiting. The specific nature of the reaction may be proved by cutaneous reaction tests with proteins derived from various articles of food. In some cases asthma may be due to sensitisation to food proteins. As a rule the patient discovers for himself the food which produces symptoms and avoids it. Sometimes it is possible to desensitise by the injection of repeated small amounts of the proteins concerned.

BROMIDE AND BARBITURATE POISONING

Bromide Intoxication—Bromides if taken in large amounts over a long period, may be retained in the body and produce

symptoms, such as confusion, disorientation, hallucinations and delusions. The reflexes are sluggish and there may be tremor and ataxia. The patient may even become stuporose. The well known bromide rash, resembling acne, is not commonly seen in these cases. If it is not known that the patient has been taking large amounts of bromide, the symptoms may be mistaken for other toxic states such as chronic alcoholism. The diagnosis can be confirmed by finding an excess of bromide in the blood. If this is above 100 mgm per 100 cc the symptoms are likely to be due to bromide. Rarely, owing to an idiosyncrasy to bromides even small doses may produce symptoms of bromide intoxication.

Treatment—Bromide should be withdrawn and the patient made to take large amounts of fluid. Elimination of bromide is effected by giving sodium chloride. This is best taken in cachets or pills containing 10 gr at two hourly intervals.

Barbiturate Poisoning—These drugs include veronal, dial, nembutal, and luminal. Overdosage may produce drowsiness, ataxia, tremor, and stupor and the patient is very liable to die of hypostatic pneumonia. In cases of acute poisoning stomach and colon lavage may be beneficial and strychnine and atropine should be given in full doses. Picrotoxin should be given intravenously in a 1 in 1000 solution at the rate of 1 cc per minute. It has a stimulating effect on the cerebral cortex and the medulla. The drug is stopped when twitching of muscles occurs or when the corneal and pupillary reflexes return. Picrotoxin is dangerous in opium poisoning. Repeated lumbar puncture with drainage of the theca is of value.

ALCOHOLISM

The problem of alcoholism has always been one of the greatest difficulties which beset the way of both social reformer and doctor and no attempt can be made here to discuss the wider aspects of the problem. Without doubt the ultimate solution will lie not in prohibition but in an improvement in the social and economic conditions of the population as a whole.

Alcoholism may be classed as acute and chronic. The first is sufficiently common to need no description. It is most important not to make a diagnosis of alcoholism in a comatose patient until other possibilities have been excluded. The smell of alcohol in the breath is of no diagnostic value, as sudden illness of all varieties is often treated by giving the patient brandy or other forms of alcohol. In case of doubt observation

for a few hours will usually settle the diagnosis. Intramuscular coramine often hastens the return of consciousness in alcoholic coma. It is well to remember that hypoglycæmia (*vide* p. 306) may exactly simulate some of the stages of acute alcoholism.

In acute alcoholism no treatment is required beyond protecting the patient from cold or exposure. In comatose patients gastric lavage accelerates recovery. Very rarely death occurs after drinking rapidly very large quantities of spirits.

A medical man may at any time be called upon to decide on the question as to whether a person is under the influence of drink while in charge of a car. Special attention should be paid to the following points: (i) Test the memory for recent and past events, noting any abnormal emotional reactions and defects of speech. (ii) Test co-ordination in walking or standing with feet together, also ability to pick up an object, such as a coin. (iii) Obtain a specimen of handwriting, being careful to provide a good light and satisfactory material for writing. (iv) Take the pulse. This is usually rapid and full, but allowance must be made for nervous factors. (v) Examine the pupils. These are usually dilated and react somewhat sluggishly. (vi) Smell the breath, bearing in mind that a smell of alcohol is not in itself evidence of alcoholism. Under the Road Traffic Act of 1930 it is an offence to be 'under the influence of drink or a drug to such an extent as to be incapable of having proper control of the vehicle'. In view of the fact that the examining doctor may have to stand a rigorous cross-examination in court he should be specially careful to make a thorough physical examination, making notes of his findings. Estimation of the alcohol content of the blood may be of value in doubtful cases. If this exceeds 2.4 parts per 1,000 it can almost certainly be assumed that the person was under the influence of alcohol in a legal sense. Lower concentrations however, do not prove sobriety.

Chronic alcoholism is a more serious proposition, producing as it does widespread changes both in the viscera and nervous system and in the intellectual capacity of the patient. The organic changes which may be brought about by the continued use of alcohol include chronic gastritis, cirrhosis of the liver, arteriosclerosis and disease of the myocardium, chronic nephritis and peripheral neuritis. Such lesions are not necessarily present in every case of chronic alcoholic poisoning, and for further details reference must be made to the sections on the diseases of the various systems concerned.

There are many factors in the ætiology of alcoholism. Heredity is certainly one, but, as has already been pointed out, direct inheritance of an alcoholic tendency is less common

than might be imagined. Often the causes are occupational, as for instance in the case of bar tenders, certain commercial travellers, or those employed in hot and dusty industries. The social surroundings also have a considerable effect on the individual, sordid housing, monotonous work, domestic unhappiness, all tend to be factors in the production of chronic alcoholism. Most important of all, however, is a psychopathic tendency in the individual, who finds alcohol a ready means of escape from the difficulties and problems which face the ordinary man.

A large number of different alcoholic psychoses have been described in some of which probably alcohol is but an incident rather than a cause, but there are four fairly well defined conditions which need separate description. These are chronic alcoholism, delirium tremens, Korsakow's syndrome, and dipsomania.

Chronic Alcoholism—In the more severe grades of chronic alcoholism the patient does not get drunk in the ordinary sense of the term, and he is often able to stand doses of alcohol which would produce manifest alcoholic symptoms in a normal person. The long continued abuse of alcohol, however, produces a typical clinical picture. Irritability and a progressive deterioration in intellect and character become apparent especially in the domestic circle, among friends and strangers the chronic alcoholic may be tolerable enough, but in the bosom of his family he is quite prepared to make the life of those around him a misery by his callous disregard for the welfare of anyone except himself, his irritability, and sometimes even his violence. In his business or profession the quality of his work deteriorates, he is careless and unpunctual, and lacks the mental concentration necessary to complete an uncongenial task. Often only under the stimulus of alcohol is he able to carry on a normal life. Depression may alternate with excitement, and suicide is not uncommon. He has but little insight into his condition, and strongly resents any suggestion that his failings are due to alcohol, he is suspicious, ready to see affronts and to pick quarrels. Sometimes there may be a paranoid reaction and delusions of persecution may arise. He is persistently untruthful, and promises to reform are invariably broken.

Occasionally chronic alcoholism is encountered in persons who, at first sight, appear to be above suspicion. This is specially true of women at about the menopause, who may indulge in secret drinking.

Physically, many alcoholics are obese and plethoric, except

in the later stages when there may be marked loss of flesh. There is a coarse tremor of the hands and tremor of the tongue and lips may render articulation difficult. Appetite is impaired and morning anorexia is often complete. The cardiac failure sometimes seen in alcoholics especially in heavy beer drinkers is probably due to lack of vitamin B (*vide* p. 510).

Delirium Tremens—This well-defined condition may arise in chronic alcoholics as the result of a debauch, or in intercurrent infections such as pneumonia, fractures or sudden withdrawal of alcohol may also produce delirium tremens. The symptoms and treatment are described on p. 1013.

Korsakow's Syndrome—This term is applied to cases in which there is a peripheral neuritis associated with a mental condition in which memory for recent events is lost, with marked disorientation (*vide* p. 1015).

Dipsomania—This condition is really a series of attacks of acute alcoholism which tend to recur at more or less fixed intervals. Between the attacks the patient may be apparently a perfectly normal individual and is often then a total abstainer, but with each attack comes an uncontrollable craving for alcohol which must be satisfied at all costs. The condition is often hereditary and tends to develop in middle life. In character the attacks are probably allied to the manic-depressive type of insanity and the ultimate prognosis is bad.

Treatment of Chronic Alcoholism—Before attempting treatment it is necessary to investigate the circumstances under which the condition has originated. If these are occupational no attempt must be made to return to the work in which temptation occurred. Every effort must be made to gain the patient's confidence and this is best achieved by regarding him not as a criminal but as the victim of a disease. In severe or longstanding cases institutional treatment is a necessity, as otherwise it is impossible to ensure the patient giving up alcohol. At the beginning of treatment decreasing amounts of alcohol are allowed, until at the end of a fortnight the allowance has been cut down to nothing. After this complete abstinence must be insisted on for the remainder of life. As alcoholism is so frequently psychological in origin, an attempt must be made to secure a readjustment of the patient's surroundings and general regime. No drug has any specific action but in the early stages of the withdrawal of alcohol, bromides and chloral may be necessary to secure sleep.

The outlook in chronic alcoholism is usually poor, particularly when the alcoholism is but one symptom of an inherent mental instability. Even after prolonged institutional treatment

relapse is frequent when the temptations and difficulties of normal life are again encountered

MORPHINISM

Morphinism is less common than alcoholism, and produces less effect upon the general health. The drug however, is more deleterious than alcohol in its effects on intellect and character. The compounds most generally employed are tincture of opium, heroin and morphine. Of recent years the Dangerous Drugs Act has increased the difficulty of obtaining the drugs, but unfortunately the addicts of morphinism will go to any lengths to obtain a supply, and usually succeed in doing so.

Drug addiction, especially where the opium group is concerned, is seldom found except in individuals with a psychopathic inheritance, and it is doubtful whether there is over any serious risk of the habit developing in a person with a normally stable nervous system. More often an exaggerated horror of drugs leads to the withholding of morphia and other sedatives in spite of indications for their administration.

In chronic poisoning by opium and its derivatives, physical health is often well maintained even when very large doses are being taken. As an example of this a medical student was found to be taking 8 gr of morphine daily and yet was able not only to carry on with his studies but also took an active part in athletics such as boxing and football.

Perhaps the most significant change in character brought about by morphinism is the complete disregard of all conventional moral qualities, such as honesty and truthfulness. A morphia addict will without a qualm rob his best friend and, if discovered, feels no sense of shame. When under the influence of the drug the patient is often amiable and may appear normal, but as its effects wear off, he becomes restless and irritable until relieved by the next dose. With complete withdrawal delirium with hallucinations may occur. With long continued use the dose needs to be progressively increased. Ultimately the general health may suffer, but the morphia habit is often consistent with a long life. This is especially true of the use of opium, which in many countries such as India is taken regularly by a large proportion of the population apparently without serious effects either on body or mind.

On physical examination the most obvious sign is myosis of the pupils, the reflexes are often diminished, and paresthesiae and hyperaesthetic areas are present. As the result of an over

dose of morphia the patient lapses into coma, with a marked slowing of the respiration rate

The *treatment* of well established morphinism is most difficult, partly because the patients are usually the subjects of an inherent nervous instability. Relapse even after apparent cure is extremely common, and continued abstinence from the drug is usually attained only by a difficulty in obtaining it. The prognosis is therefore, specially bad among doctors and nurses, who can seldom resist the opportunities which fall in their way. The only satisfactory method of dealing with morphia addicts is strict confinement in an institution, where they can be prevented from obtaining access to the drug. Great care must be taken to ensure that the patient does not secrete a supply of the drug on his person before he enters the institution.

Sudden and complete withdrawal of the drug may produce dangerous collapse, especially in elderly and debilitated persons. It is best withdrawn gradually over a period of about fourteen days. For the restlessness and distress produced by abstinence large doses of bromide, chloral, or luminal may be required. The bowels should be kept freely open to aid in elimination of the drug. In dealing with elderly addicts, who have been taking the drug for years, attempts to withdraw the drug are more likely to shorten the patient's life than to lengthen it.

The permanence of cure depends mainly upon the patient being enabled to live a sheltered life. With exposure to financial, business, or domestic worries, or to physical or nervous strain there is a grave risk of a return to drug taking.

COCAINISM

Cocaine may be taken hypodermically, by mouth, or in the form of snuff, but the last method is that most frequently employed.

It has already been stated that morphinism seldom develops, apart from some psychopathic tendency. This is even more true of the cocaine habit, which is often started deliberately. Cocaine addicts, owing to the expense of the habit, are nearly all drawn from among the wealthy classes, but it may occur among the large number of agents who are engaged in the illegal distribution of cocaine. Anorexia is perhaps the most marked symptom. The cocaine addict can practically dispense with food altogether. Unlike morphia, cocaine is a stimulant, which produces a temporary sense of well being and mental activity, but as the effects of the drug wear off there is depression

and irritability until a further dose is taken. Morally there is rapid deterioration, and the unfortunate addict soon comes completely under the control of those who supply him with the drug, to obtain a supply of which he is ready to stop at nothing. Suicide is not uncommon, or death may occur from an accidental overdose. The emotional state varies between exaltation and dejection, vivid and terrible nocturnal hallucinations are common. The pupils are dilated and the eyes have a sparkling appearance while under the influence of the drug.

As regards treatment, the first essential is that the confidence of the patient should be obtained, as without his co-operation it is almost impossible to prevent him obtaining the drug. A complete breach in the patient's relationship with other addicts and with the illegal traffickers in the drug is essential.

Unlike morphia, cocaine may be completely withdrawn at once, but the patient must be under close personal supervision, either in an institution or at home. If the craving for the drug becomes intense it may be relieved by giving hyoscine, preferably by mouth. The general health should be attended to by keeping the bowels freely open with salines and by exercise with plenty of open air.

J J CONYBEARE

may be considerable and unsightly it seldom produces symptoms. Dyspnoea and compression of the trachea however may accompany a very large thyroid or a retrosternal goitre. A gland so situated may give rise to severe pressure symptoms similar to those resulting from other mediastinal neoplasms (*vide p. 659*).

The gland itself may be enlarged as the result of a generalised increase in the colloid substance in the alveoli or there may be localised adenomatous enlargements in which cysts may develop. The condition is then termed cystic adenoma. Adenomatous enlargement of the thyroid may ultimately lead to toxic symptoms of hyperthyroidism.

Treatment—In endemic areas prophylaxis has proved most effective. Sodium iodide is given for a fortnight twice a year to all children. Each course consists of about 30 gr. For therapeutic purposes the dose should not exceed 5 gr. daily. Definite localised adenomata are much better treated by operative removal. Many adolescent goitres represent physiological enlargement of the gland and tend to disappear without treatment.

Carcinoma and Thyroiditis—This condition is fortunately rare. It may occur spontaneously in a normal thyroid in middle age or perhaps more commonly a carcinoma develops in an adenomatous goitre which has been present for many years. Surrounding parts are rapidly invaded leading to fixation of the gland and there is enlargement of the adjacent lymph glands with secondary deposits especially in bones. The only effective treatment is early surgical excision.

Thyroiditis—Acute inflammation of the thyroid may produce an abscess which requires drainage. Chronic inflammatory changes may also occur known as *Riedel's thyroiditis* or "woody" thyroid. In this condition the thyroid is enlarged, hard and often tender and there is a great increase in fibrous tissue. Involvement of the recurrent laryngeal nerves may produce paralysis of a vocal cord and there is often pain on swallowing and referred pains in the chest and neck. The nature of the inflammatory process is unknown and the condition is sometimes progressive in spite of thyroidectomy.

THYROTOXICOSIS

(*Exophthalmic Goitre, Graves's Disease, Hyperthyroidism, Toxic Adenoma*)

Morbid Anatomy—The histological picture is one of general hyperplasia of the gland. The al

and there is little colloid to be seen. The alveolar cells are columnar and are arranged irregularly in multiple layers with the formation of papillary ingrowths in place of the single layer of cuboidal cells which lines the normally secreting alveolus. The amount of fibrous tissue increases as the condition becomes chronic. Lymphocytic infiltration is a prominent feature. In some cases the gland may show single or multiple adenomata in various stages of development or degeneration.

Enlargement of the thymus at autopsy is seen in about half the cases. Evidence of myocardial degeneration is rare even in patients dying of cardiac insufficiency.

Ætiology—Thyrotoxicosis is frequently preceded by emotional strain. It occurs more frequently in women than in men. It presents a variety of clinical pictures depending on the age and previous make up of the patient, picking out and emphasising the weaknesses of the patient's constitutional diathesis. Nutritional deficiency may play its part. The cardiac symptoms and psychotic manifestations are reminiscent of avitaminosis B. Symptoms of thyrotoxicosis have been produced experimentally by administration of the pituitary thyrotrophic hormone and by anastomosis of the phrenic and cervical sympathetic nerves. The condition shows elements of pure hyperthyroidism, such as the increased basal metabolic rate, as well as symptoms, such as exophthalmos, not normally manifested by simple excessive secretion of the thyroid hormone. For this reason Plummer's theory of secretion of both excessive normal and of an abnormal type of thyroid hormone was attractive. There is, however, little evidence of dysthyroidism; there is indeed little evidence for the secretion of abnormal hormones in endocrinology generally. Ineffective secretion of the hormone is probably the key to the ætiological picture, and Harington's hypothesis of "thyroid diarrhoea" has much to commend it. He gives a picture of a gland with leakage of its essential hormone. All efforts to store iodine in the form of colloid are frustrated by this leak. This probably stimulates the pituitary and under the influence of its thyrotrophic hormone the histological picture of increased glandular activity of the thyroid and the clinical picture of Graves's disease appear. Administration of iodine is temporarily beneficial by helping to plug the leak.

Symptoms—The onset of thyrotoxicosis is often remarkably sudden, and the development of one or more symptoms may bring the patient for advice within a few weeks of their appearance. Not infrequently, however, particularly in patients of middle age and over, the onset may be insidious, and such

cases are liable to be misdiagnosed as heart disease or neurasthenia. As the symptoms and signs vary considerably in every case, they are best considered separately.

1. *Thyroid Gland*—The enlargement of the thyroid is very variable in extent, and the severity of the disease by no means coincides with the degree of glandular enlargement. Occasionally, indeed, there may be no obvious enlargement clinically, although the gland on section may show characteristic hyperplasia. The blood supply is much increased, and a systolic or continuous murmur, often very loud, may be heard over the gland, in severe cases a thrill may also be felt. The enlargement usually involves both lobes and the isthmus, and the gland forms an obvious tumour in the neck, which can be seen to move on swallowing. In the earlier stages of the disease the thyroid is of normal consistency, but later on may become unduly firm from an increase in fibrous tissue. This is often the case after treatment with iodine.

When thyrotoxicosis develops in a patient with an old-standing goitre, the gland is usually hard and nodular, but sometimes symptoms may arise when there is nothing beyond a very small and localised adenoma.

2. *Heart*—A rapid but regular action of the heart is one of the earliest and most constant findings in thyrotoxicosis. The rate may range from 100 to 160 beats per minute, and under the influence of any excitement or emotion there is a rapid acceleration. The ventricular contractions are powerful, and there is often marked pulsation in the neck. The pulse pressure is frequently increased. In the earlier stages of the disease the heart is of normal size and the rhythm regular, but when tachycardia has persisted for a long period, dilatation, myocardial insufficiency, and eventually auricular fibrillation may develop. Cardiac symptoms are particularly prominent in patients of over middle age.

3. *Exophthalmos*—Although not invariably, there is some protrusion of the eyes in the great majority of cases, especially those below thirty years of age. The exophthalmos often occurs early, and may persist long after the disease has become quiescent. Even minor degrees of the condition are readily noticeable, and during the acute phases of the disease there is a characteristic staring appearance. Rarely conjunctivitis and corneal ulceration may result from inability to close the eyes. The classical signs of exophthalmos, such as a lagging of the upper eyelid on looking downwards (Von Graefe's sign) and a spasm or retraction of the upper lid with inability to blink (Stellwag's sign), are of little help in diagnosis as they

are not present until exophthalmos is evident at the first glance at the patient. Occasionally the exophthalmos is unilateral. It is probable that exophthalmos is not due to the hyperthyroidism but to thyrotrophic hormone of the anterior pituitary.

4 *Loss of Weight*—This is perhaps the most constant and significant symptom in thyrotoxicosis as it is an index of the increase in the metabolism which results from excessive secretion by the thyroid. At the onset of the disease there is a comparatively rapid loss of weight but as the condition of the patient becomes stabilised or when a remission in the severity of the disease occurs the weight may cease to diminish or begin to increase. A careful chart should be kept of the weight as by this means it is usually possible to determine whether or not the patient is improving.

5 *Muscular Fatigue*—One of the earliest and most prominent symptoms of thyrotoxicosis is muscular fatigue which may be readily demonstrated by making the patient step up and down on to a chair. In some cases of severe thyrotoxicosis the skeletal muscles are so atrophied and weak that the condition closely resembles progressive muscular atrophy. After thyroidectomy great improvement may occur and the muscles regenerate.

6 *Nervous Symptoms*—Mental instability is always a marked feature especially in younger patients. The patient is restless even when in bed irritable and very prone to be upset by small annoyances. Depression is common and weeping occurs without obvious cause. In severe cases the restlessness may amount to mania and delirium and these symptoms are of grave significance. Tremor of the fingers is a constant feature and is best seen when the hands are outstretched and the fingers separated. Unlike that of alcoholism the tremor is fine in character and interferes but little with voluntary movements.

7 *Gastro intestinal Symptoms*—These are absent except during the exacerbations or crises of the disease. Usually the patient has a normal appetite and the bowels are regular. Gastro intestinal crises as they are termed consist of vomiting and diarrhoea which may be both severe and intractable and often herald death. There is evidence that there is some degree of impairment of liver function in thyrotoxicosis this can be demonstrated by the galactose tolerance test.

8 *Skin*—This is warm and moist and the patient often complains of feeling hot. Patients with thyrotoxicosis always prefer cold to hot weather. The hair may fall out and the skin is sometimes pigmented.

9 *Generative Organs*—The menses are scanty, irregular or absent. During pregnancy symptoms are sometimes temporarily improved but relapse is apt to occur after parturition.

10 *Urine*—There is a lowering of sugar tolerance and glycosuria may result.

Course of Thyrotoxicosis—In untreated cases especially in the younger group of patients exacerbations tend to alternate with periods of comparative quiescence. During the exacerbations nervous and gastro intestinal symptoms may be very serious and the exophthalmos becomes more obvious. In older patients especially those with auricular fibrillation and cardiac decompensation the course of the disease may progress steadily downwards and in the absence of treatment the patient dies of congestive cardiac failure.

A small proportion of relatively mild cases may recover completely within twelve months but as a rule the disease unless dealt with surgically persists for many years unless death results from intercurrent infection heart failure or exhaustion in a crisis of thyrotoxicosis.

Differential Diagnosis—Very often a diagnosis of thyrotoxicosis is obvious at first glance. This is particularly true of the acute type of case so often seen in young women. On the other hand it is sometimes very difficult to decide whether a patient is suffering from thyrotoxicosis or an anxiety state. In the latter the pulse may be rapid especially when the patient is first seen but as a rule it falls to a normal figure when the patient is at rest. With the tachycardia of anxiety and excitement sinus arrhythmia is usually well marked whereas in thyrotoxicosis sinus arrhythmia cannot be detected clinically. Patients suffering from anxiety states may exhibit emotional instability not unlike that of thyrotoxicosis and indeed the disease not infrequently develops in patients who have for many years suffered from conditions of anxiety and neurasthenia.

Estimation of the basal metabolic rate is seldom of great value in the differential diagnosis between thyrotoxicosis and an anxiety state as in the latter the agitation of the patient often prevents a true basal figure being obtained. Fortunately a period of observation in hospital enables a definite diagnosis to be made.

Occasionally tuberculosis may be suspected in cases of thyrotoxicosis where tachycardia and loss of weight are the chief features but as a rule enlargement of the thyroid or other features help to elucidate the condition.

When cardiac symptoms, such as palpitation, dyspnea, and especially auricular fibrillation are prominent features, it is easy to overlook their thyroid origin. Many cases of hyperthyroidism occur after middle age in patients with adenomata of the thyroid, in which exophthalmos is absent and the symptoms are primarily cardiac. It is therefore *most important always to make a careful examination of the thyroid in every patient who develops obscure cardiac symptoms*.

Basal Metabolic Rate (B M R)—Estimations of the B M R are of great value both in diagnosis and as a guide regarding the progress under treatment. In this procedure the rate of absorption of oxygen is estimated and is expressed as a percentage of the amount which would be used by a normal person, taking into consideration the factors of sex, age, height, and weight. In severe hyperthyroidism the B M R may be as much as 170 per cent of the normal. Such a figure is expressed by the term $+70$.

Treatment—It has already been stated that patients with thyrotoxicosis may make a spontaneous recovery in the course of years provided they survive the risks due to "crises" of the disease or secondary infections. With the improvement in operative technique and anesthesia subtotal thyroidectomy offers reasonable certainty of a rapid recovery. In some mild cases, however, medical treatment may be tried for a few months. No drugs have any specific effect, but sedatives such as phenobarbitone ($\frac{1}{2}$ gr noct mane q) are always advisable to diminish the nervous excitability. Even more important is the general regime. The patient should rest as much as possible, though absolute confinement to bed is not essential in most cases. The diet should be generous with a high caloric content but only a moderate amount of protein is advisable owing to its stimulating effect on metabolism. It must be remembered that patients with thyrotoxicosis are peculiarly liable to secondary infections which often produce a disastrous exacerbation of their symptoms. Medical treatment in an ordinary hospital ward is always dangerous. Quite apart from the risk of acquiring secondary infections, the association with disease and death has an exceedingly bad effect, and if treatment in hospital is essential the patient should be in a private room. Complete avoidance of domestic worries and anxieties is important.

Treatment with Iodine—The value of iodine in exophthalmic goitre has been thoroughly substantiated. It reduces the B M R to a lower though not to normal figure and the symptoms of hyperthyroidism become less striking. Iodine

medication is mainly useful as a pre operative measure. If the drug is administered over a prolonged period the initial improvement disappears. Moreover, iodine appears to produce its maximum effect only at its first administration, and a further course of iodine after an interval is of less benefit. It is, therefore, usually inadvisable to employ iodine therapy indiscriminately in patients who are likely eventually to require operation, in order that a pre operative course of the drug will produce the maximal effect. This usually occurs after ten to fourteen days and operation should be undertaken about this time.

The value of iodine, therefore, lies in the fact that it produces a temporary improvement or remission of symptoms, during which the patient may safely be submitted to thyroidectomy. It is specially valuable during the "crises" of the disease in which it rapidly allays the restlessness and excitability, and stops the diarrhoea and vomiting. Thus iodine can render operable many cases that without its use would be too ill to justify operation. Even in mild cases of thyrotoxicosis it is wise to give iodine as a pre operative measure. As a result of iodine treatment the mortality of thyroidectomy has fallen to less than 1 per cent.

Iodine is best given by mouth in the form of Lugol's solution (iodine 5 per cent, potassium iodide 10 per cent). The initial dose should be about 5 minims of Lugol's solution thrice daily, and this is rapidly increased to a total of 30 or even of 45 minims *per diem* for some days before operation. The temporary exacerbation of hyperthyroidism which often occurs immediately after operation should be combated by large doses of iodine up to 100 minims in the first twenty four hours. As the patient improves iodine is withdrawn and may be omitted completely within a week to ten days. If vomiting prevents absorption of iodine by mouth it may be given rectally, or in desperate cases by the intravenous drip injection of sodium iodide (7.5 gr. in a litre of normal saline).

Radium or Deep X ray Treatment—These are often effective in relieving the symptoms of exophthalmic goitre, but courses of treatment must be repeated and results are uncertain. When for any reason such as an associated tuberculous infection, operation is undesirable, X ray treatment should be advised.

Operative Treatment—The essentials for success are as follows: (i) A skilful surgeon who has had ample experience of thyroid surgery, (ii) adequate pre operative treatment with iodine, (iii) skilful anaesthesia preferably a basal anaesthetic followed by gas and oxygen. Ether should be avoided.

Thyroidectomy is contraindicated in patients whose symptoms are due to an anxiety state, even if there is evidence of some degree of thyrotoxicosis in addition, as the results in such cases are often very disappointing. Nor is it wise to press for operative treatment if the patient is opposed to the idea.

It must be realised, however, that even the most successful operation does not cure the patient forthwith, though there is often a striking and rapid improvement. A varying period of rest and quietude is necessary, and occasionally a further operation may be required.

When hyperthyroidism occurs in a patient with an adenomatous goitre—so called toxic adenoma—operation should be performed at the earliest possible moment. Even with a decompensated heart and auricular fibrillation results are often good and without operation the patient usually dies of cardiac failure. After operation the heart appears to have remarkable recuperative powers. When fibrillation is present digitalis should be given to slow the ventricular rate. Following thyroidectomy the fibrillation often disappears spontaneously. If this does not occur quinidine should be tried.

MYXŒDEMA

Myxœdema is a chronic disease of adults resulting from deficiency of thyroid secretion, characterised by a low basal metabolism, increase of weight, thickening of the skin, and mental disturbance.

The disorder is more common in women than in men and occurs most frequently after the age of forty. Its onset is usually insidious and has been attributed to either functional exhaustion of the gland as the result of long continued stimulation or to the actual replacement of the gland by fibrous tissue. The latter condition may be brought about by the influence of infections. Sometimes myxœdema occurs in the late stages of exophthalmic goitre, or it may follow a partial thyroidectomy, if too much of the thyroid has been removed.

Symptoms—In myxœdema most of the symptoms are the reverse of those found in hyperthyroidism.

1 *Thyroid Gland*—This is either normal in size, or it may be so shrunken as to be completely impalpable.

2 *Heart*—The pulse is slow but the blood pressure is often raised, and arteriosclerosis may be present.

3 *Weight*—There is a marked gain in weight, often amounting to over a stone in a few months. This is due partly

to the low rate of basal metabolism, partly to the thickening of the skin and subcutaneous tissues

4 *Nervous System*—Patients with myxœdema become slow both in physical movements and cerebration. They lose their memory and suffer from apathy and somnolence. Special senses are often blunted, especially hearing.

5 *The Skin*—The changes which occur in the skin and subcutaneous tissues give the myxœdematous patient a characteristic expressionless appearance. A general thickening and infiltration of these tissues occur all over the body, this differs from ordinary œdema in that there is no pitting on pressure. The facial appearance alters and the finer features become obliterated, so that eventually all patients with myxœdema show a remarkable resemblance to one another. The skin is dry and scaly, and the nails become brittle and atrophic. The hair is coarse and often falls out. This occurs not only on the scalp but all over the body. Loss of hair on the outer sides of the eyebrows is characteristic.

6 *Temperature*—The temperature is subnormal and may fall as low as 93°F , myxœdematous patients are particularly sensitive to cold and feel very much better in hot weather.

7 *Alimentary System*—The appetite is usually poor and constipation is common. Sometimes abdominal distension as a result of deficient peristalsis in the intestines is troublesome.

The basal metabolic rate is always low and may be reduced to 30 or 40 per cent below normal. As a result of treatment with thyroid extract the rate rises to normal, and at the same time the body temperature increases.

The disease if left untreated is steadily, if slowly, progressive, and death occurs from exhaustion or intercurrent infection. Its duration extends over many years. At autopsy the thyroid is found to be much diminished in weight, as the result of atrophy of the glandular epithelium or its replacement by fibrous tissue. The skin shows atrophy of the sebaceous glands and a general thickening due to fibrils of connective tissue rather than infiltration with fluid.

Apart from the fully developed condition of myxœdema described above, minor degrees frequently occur in which the patient becomes listless and apathetic without the development of the characteristic changes in the skin. These forms of the disease known as hypothyroidism rather than myxœdema, probably result mainly from prolonged over stimulation and consequent exhaustion of the thyroid.

Treatment—Fortunately we have 1

specific remedy, which is nearly always effective. It is given by mouth as tablets of a dried extract of thyroid (Thyroideum B P) in doses of $\frac{1}{2}$ to 4 gr. The initial dose is $\frac{1}{2}$ gr twice or three times a day, and this must be cautiously increased until the symptoms of myxœdema are relieved. It is seldom that more than 3 gr a day are necessary. Useful guides as to the quantity required are the temperature and the pulse rate. Overdosage may cause palpitation and tachycardia. When the correct dosage has been found it must be continued indefinitely if relapse is to be avoided.

CRETINISM—This condition is one of hypothyroidism, occurring in infancy. It is specially common in regions where goitre is endemic, and is due to a failure of the thyroid to develop during foetal life.

At birth the infant may appear normal, but within a year it becomes obvious that its progress, both as regards growth and intelligence, is delayed. Growth, particularly of the extremities, remains stunted, and an adult cretin may retain the stature of a child. The skin is rough and dry, the nostrils wide, and the nose sunken. The abdomen is distended, an umbilical hernia is often present, and constipation is marked. The development of the intellectual faculties is always delayed and usually remains permanently below normal.

Treatment is by the administration of thyroid extract. Its effects, especially if started early in life, may be remarkably satisfactory. The dosage varies considerably in individual cases, but is usually about 2 gr of the dry extract daily. This must be continued throughout life, which is not necessarily curtailed by the disease.

PARATHYROID GLANDS

The parathyroid glands are four minute bodies embedded in the tissue of the thyroid. Removal produces tetany, which is characterised by increased excitability of the motor nerves with tremors and muscular spasm. The parathyroids may be removed or damaged as a result of partial thyroidectomy, and in such cases tetany may occur shortly after the operation.

The function of the parathyroids is the production of a hormone, which regulates calcium metabolism. In normal human blood the serum calcium is 10 mgm per 100 cc, in tetany, due to parathyroid deficiency, the serum calcium may fall as low as 6 mgm per 100 cc, administration of the active principle of the parathyroid raises the calcium in

the blood, prolonged administration mobilises calcium from the bones and thereby increases the amount of calcium in the blood

Generalised Osteitis Fibrosa.—This is a relatively rare disease occurring in early adult life. An adenoma of the parathyroid gland is present, which produces hyperparathyroidism. The blood calcium is high—often up to 15 mgm—and the calcium in the urine is increased. The bones become partially decalcified and cystic. Ultimately spontaneous fractures occur and the patient becomes bedridden. In about 30 per cent of cases renal calculi form, probably owing to the increased excretion of calcium in the urine. The only effective treatment is removal of the parathyroid adenoma. Unfortunately this is often very small and difficult to find, even on exploration. Following operation the patient may suffer from tetany.

TETANY

Although there is evidence, both clinical and experimental, which associates tetany with damage to or destruction of the parathyroids, similar clinical manifestations occur frequently in other pathological conditions in which there is no evidence of parathyroid insufficiency. Tetany is common in infants, particularly in association with rickets and gastro intestinal disorders (*vide p 235*). In adults typical attacks of tetany due to alkalosis very occasionally occur in pyloric obstruction (*vide p 406*). Similar attacks result from pulmonary hyperventilation and are sometimes described as "spontaneous overbreathing tetany". The hyperpnoea is hysterical. Tetany may also occur during pregnancy or lactation. As has already been mentioned, tetany may follow operations on the thyroid.

Symptoms—The most prominent symptoms of tetany are the muscular cramps, which affect particularly the extremities. The attacks of cramp last for a variable time, from a few minutes to several hours, and are usually painful. The hands and forearms are most commonly affected, and during a spasm present a characteristic appearance. The fingers are flexed at the metacarpo phalangeal and extended at the interphalangeal joints, the thumb is adducted into the palm, and the fingers are drawn closely together, thus producing what has been termed by Trousseau the "*main d'accoucheur*". The wrists and elbows are flexed and the arms adducted. When the condition affects the feet a rather similar position is produced. In severe cases there may be generalised epileptiform convulsions.

associated with the differentiation of sex and the development of secondary sexual characteristics. The main function of the medulla is the production of an internal secretion which is discharged into the general circulation through the veins leading from the suprarenal glands. This substance has been prepared synthetically and is known as adrenalin. It has a specific stimulating effect on sympathetic nerve endings, and its presence in the blood leads to vaso constriction, a rise of blood pressure, dilatation of the bronchioles and a conversion of glycogen in the liver into glucose. According to the attractive theory of Cannon the adrenals liberate an increased supply of adrenalin during periods of emotion, such as anger, excitement, or fear, and thereby assist in preparing the tissues for the extra strain thrown upon them in battle or flight.

Experimental removal of the adrenals or their destruction by disease produces a marked loss of tone in the vascular system and asthenia, which ultimately results in death. The adrenals become exhausted during acute infections and also in severe traumatic injuries and extensive burns. In a normal healthy adult subcutaneous injection of as little as 10 minims of a 1 in 1,000 solution of adrenalin may raise the blood pressure considerably and produce unpleasant symptoms, whereas in a severe infection such as pneumonia similar amounts can be given to an infant without producing marked effects.

The diseases which involve the adrenal gland are Addison's disease, in which there is a destruction or atrophy of the gland, and new growths, which may produce symptoms due to hypertrophy of the cortex.

ADDISON'S DISEASE

In 1855 Addison published a paper entitled "On the Constitutional and Local Effects of Disease of the Suprarenal Capsules," in which he described as follows the characteristic features of the disease which has come to bear his name: "*Anæmia, general languor and debility, remarkable feebleness of the heart's action, irritability of the stomach and a peculiar change of colour in the skin.*"

Symptoms—The cardinal symptoms of Addison's disease are a marked and progressive asthenia, a low blood pressure, and pigmentation of the skin and buccal mucous membranes. The severity of the symptoms fluctuates, and at times there are exacerbations or "crises" during which the blood pressure falls, vomiting is severe, and collapse is alarming. Death usually supervenes in the absence of effective treatment.

1 *Asthenia* —Languor, debility, and loss of muscular power are the symptoms which first indicate the onset of the disease. Appetite is lost and the patient is indisposed to undertake work, either physical or mental.

2 *Blood Pressure* —Both the systolic and diastolic readings are low, and the former rarely exceeds 100 mm. of mercury when the disease is first diagnosed. In the later stages there is a steady fall in blood pressure.

3 *Pigmentation* —This symptom occasionally appears early, and may be the first sign of the disease. Rarely, it is completely absent throughout, but usually the pigmentation becomes more marked as the disease progresses. There is a generalised discoloration of the skin, especially marked in the flexures and the naturally pigmented areas of the body. The colour varies from brown to a dark black, and the pigment is distributed as small spots or larger areas. In the mouth irregular patches of pigmentation appear on the mucous membrane of the lips and cheeks upon the gums or the palate.

In addition to the symptoms detailed above, vomiting is extremely common particularly in the later stages of the disease where it is probably due to the profound circulatory disturbance. Attacks of vertigo and syncope are frequent, and presumably due to a similar cause. Although Addison described anæmia as a symptom the hæmoglobin percentage is seldom below sixty, and the blood picture is not characteristic.

In the absence of treatment a fatal issue is usually not long delayed once the typical symptoms have developed. Occasionally it is the result of an intercurrent infection, but more often it occurs suddenly. Rarely life is prolonged for several years.

Morbid Anatomy —The characteristic picture of Addison's disease is produced by two pathological conditions only, either bilateral destruction of the glands by a fibro caseous tuberculous process or more rarely by an atrophy of the glands which is sometimes so extreme that no trace of suprarenal can be discovered at autopsy. Active tuberculosis elsewhere is unusual.

Diagnosis —As with all diseases as rare as Addison's disease, the diagnosis is not infrequently proved to be wrong. Pigmentation, asthenia, and low blood pressure may be the most prominent features in cachectic states due to carcinoma, anorexia nervosa, and Simmonds' disease. Pigmentation of the buccal mucosa is, however, absent in these conditions.

The possibility of pigmentation as the result of descent from non European ancestors must be borne in mind

Treatment—An important feature of the condition is a diminution of the serum sodium figure and, to a less extent, of the blood chlorides. The blood potassium may be raised, particularly during a relapse. Oral administration of sodium chloride (10-20 grm daily) is therefore beneficial in maintaining health in the intervals between crises. Such large quantities of salt may, however, act as an emetic, in which case the sodium should be given as a mixture of chloride, bicarbonate, and citrate. This treatment should be continued throughout the patient's life. In view of the hypoglycæmia which is often found in Addison's disease, the patient should take plenty of glucose.

During the crises of Addison's disease it is necessary to give intravenous glucose saline to restore the serum ionic values and the loss of fluid. Cortical extract should be given in daily doses of 20 to 100 c.c. in the saline. When improvement has occurred a maintenance dose of 5 to 10 c.c. intramuscularly may be continued daily. The expense of this is unfortunately usually prohibitive.

The active principle, corticosterone, has been isolated, and recently a closely related synthetic product known as desoxycorticosterone acetate has been prepared. This substance is marketed as an oily suspension for intramuscular injection under the names of Percorten and Doca and has been shown to exert a very striking beneficial effect in Addison's disease. The usual daily dose is 5 mgm., though larger doses are indicated in periods of crisis.

TUMOURS OF THE ADRENAL GLANDS

Medullary tumours are rare and arise either from the chromaffin cells (phaeochromocytoma) or from the sympathetic ganglion cells (neuroblastoma). The former give rise to paroxysmal or continuous hypertension. The latter occur only in children and are highly malignant. They may be characterised by metastases in the liver, lungs, and abdominal glands (Pepper's syndrome), or in the cranium and behind the orbit, causing proptosis and papilloedema (Hutchinson's syndrome). Cortical tumours give rise to the adreno-genital syndrome of which the chief feature is masculinisation which differs in severity according to the age at which the tumour appears. It occurs during foetal life only in females and leads to pseudo-hermaphroditism. Before puberty the condition is most marked

in boys, in whom the genitalia develop adult proportions, usually with precocious sexual desire. There is excessive growth of hair especially on the face, axillæ and pubis and there may be excessive muscular development—the so called infant Hercules type.

In adults the condition is confined to women who show varying degrees of virilism from minor degrees of hypertrichosis to a condition closely resembling Cushing's syndrome (see p. 287) with localised obesity, amenorrhœa masculinisation of the external genitalia, and hypertension. The adrenogenital syndrome may be due to simple hyperplasia of the deepest layer of the cortex, the androgenic zone, or to a cortical adenoma in which malignant changes may subsequently occur. It appears to be associated with the excretion in the urine of a substance, adrenosterone, which has androgenic properties.

Treatment of an established tumour, especially when there is evidence of malignancy is surgical and consists in the removal of the affected adrenal. Assistance may be obtained in determining in which gland the growth is situated by defining the position of the kidney, which may be displaced downwards if the tumour is large by uroselectin pyelography or injection of air into the perirenal region with subsequent radiography.

In the milder forms of adrenal virilism characterised only by hirsuties and possibly, raised blood pressure so serious a course as surgical interference is unwarranted. In such cases a tumour is seldom present. Unfortunately hormone therapy has so far proved ineffective and there is no alternative to local remedies for removal of the excessive and unsightly growth of hair.

THYMUS GLAND

Little is known of the physiology of the thymus. Experimental extirpation of the gland has not given constant results. *The gland enlarges until puberty, and after that time becomes smaller, until in late middle life practically none of it remains.*

The thymus is found to be enlarged in certain diseases notably exophthalmic goitre, acromegaly, and myasthenia gravis but perhaps the commonest condition in which thymic hyperplasia is found is *status lymphaticus*. This term is employed to describe a condition sometimes found at autopsy in persons who have died suddenly without apparent cause most often during an anæsthetic. In such cases the thymus is often considerably enlarged and there is also some general

increase in the lymphoid tissue throughout the body *Status lymphaticus* is unlikely to be diagnosed during life. When death occurs, it results from sudden cessation of the heart beat rather than from respiratory failure.

In infants an enlarged thymus may give rise to paroxysms of dyspnoea, which have been termed thymic asthma. There may be marked stridor and cyanosis, which occasionally result in death.

GONADS

Apart from their functions in the production of spermatozoa and ova, the reproductive organs play an important part in the development of secondary sexual characteristics, and a consideration of their secretions chiefly concerns the endocrinologist and the gynaecologist, but from the point of view of a medical textbook there is only one condition which calls for notice, namely, the group of symptoms associated with the cessation of menstruation and ovarian hypofunction, known as the menopause.

THE MENOPAUSE—Although, strictly speaking, the menopause is a normal physiological process, which usually occurs between the ages of forty five and fifty five, it is often associated with so many and so diverse symptoms that it almost merits the name of a disease. Indeed, it is perhaps the commonest condition which the medical man is called upon to treat in women of middle age. Similar symptoms may occur in earlier life as the result of an artificial menopause.

The local changes which occur in the genital organs are discussed in works of gynaecology, but every practitioner needs to be familiar with the symptoms of the menopause, more especially as in many cases he will be able to add greatly to the patient's comfort during this difficult period.

In many women menstruation continues regularly up to the time of the menopause and then ceases suddenly, without producing any disturbance, either local or general. Unfortunately, however, there is often a period, sometimes prolonged over several years during which menstruation may be markedly irregular, and during which the patient is in constant suffering both physical and mental.

The most characteristic symptom of the menopause is the occurrence of what are termed "hot flushes." Suddenly and for no apparent reason a sensation of great heat is experienced all over the body, the skin becomes flushed, and profuse sweating may occur. The functions of practically every

system in the body may become deranged, though there is no manifestation of organic disease. Tachycardia, palpitation, and feelings of oppression in the chest, pain in the back or in the limbs, arthritis, headache, vertigo, disturbances of appetite and digestion are all common accompaniments of the menopause. Later and more severe sequelæ are pruritus, kraurosis and leukoplakia vulvæ. Perhaps most important of all are the nervous symptoms. The patient is irritable and readily upset by trifles, and makes life a burden not only to herself but to all around her. Obsessions and delusions may occur, and the character and whole outlook may change. Recourse may be had to drugs, alcoholic or religious excess, and sometimes the mental condition may be such that certification is necessary.

Treatment—Treatment consists in sympathy, reassurance, and administration of oestrogenic hormone. This may be given in the form of oestrone (by mouth) oestradiol henzoate (by injection) or stilboestrol, a synthetic compound which is both cheap and highly effective by oral administration, but which produces in about 20 per cent of cases mild and usually transient toxic symptoms such as nausea and headache. Preparations of these substances are presented unfortunately under a confusing variety of proprietary names. Daily dosage varies according to the severity of the symptoms from 0.5 mgm. by mouth to 1 mgm. by injection. The aim should be to determine as quickly as possible the minimal effective dose and then to decrease rather than to increase it. A record of the daily hot flush count may help in the assessment of progress.

It is important to remember that organic disease is prone to develop about the age at which the menopause occurs, and no case should be lightly dismissed with a diagnosis of menopause unless a thorough physical examination has been carried out.

THE PITUITARY GLAND

Physiology—The pituitary consists of a glandular portion, the anterior lobe and pars intermedia, embryologically derived from the foregut by an upward growth from the naso-pharynx, known as Rathke's pouch, and a nervous element, the posterior lobe, consisting of a downgrowth of neuroglial tissue from the diencephalon.

The anterior lobe is composed of cells, 50 per cent of which, the chromophobe cells, contain no granules, and therefore

probably produce no active principle. Of the remainder, the chromophil cells, three quarters contain acid staining granules, the eosinophil cells, while coarse basophilic granules are found in the rest, the basophil cells. The chromophil cells secrete directly into the vascular sinuses which they surround. At least six endocrine activities have been ascribed to the anterior lobe. These are —

- 1 The *growth* hormone, which is secreted by the eosinophil cells and regulates skeletal growth.
- 2 The *gonadotrophic* factors, which control the functional activity of the ovary and testis. Two types of extract are at present available.

Chorionic gonadotrophin derived from the placenta and from the urine of pregnant women. It is the presence in excess of this factor in pregnancy urine which forms the basis of the Aschheim Zondek and Friedman tests for pregnancy. Injection of such urine produces precocious development of corpora lutea in infantile mice in the former test, and induces ovulation in the adult rabbit in the latter.

Serum gonadotrophin extract from the blood serum of pregnant mares. This induces follicular maturation and spermatogenesis in infantile animals.

- 3 The *thyrotrophic* hormone which controls the activity of the thyroid gland. There is experimental evidence to show that continued injection of thyrotrophic extracts results in the development of an anti thyrotrophic principle, which may cause atrophy of the thyroid gland with lowering of the basal metabolism.
- 4 *Prolactin*, which stimulates the secretion of milk from the mammary glands.
- 5 The *adrenotrophic* hormone, which controls the activity of the adrenal cortex.
- 6 The *diabetogenic* principle, which antagonises the effect of insulin, and the *ketogenic* principle, which facilitates the conversion of fats to liver glycogen with a tendency to the production of ketosis.

The *pars intermedia* is usually described as belonging to the posterior lobe. It consists of a thin strip of tissue composed of layers of basophil cells, similar in structure to those of the

anterior lobe Its secretions pass by way of the pars nervosa into the cerebrospinal fluid of the third ventricle It is probable that interference with this path by lesions in the posterior lobe, the pituitary stalk or the overlying hypothalamic region may give rise to disorders of fat, carbohydrate or water metabolism, leading to obesity, lowered sugar tolerance or diabetes insipidus The pars intermedia secretes two hormones One of these, *vasopressin*, stimulates smooth muscle, producing constriction of the capillaries, peristalsis of the intestines, and contraction of the muscle surrounding the mammary ducts, resulting in the expression of previously secreted milk—galactagogue effect It also inhibits the flow of urine The other, *oxytocin*, stimulates uterine contractions Commercial extracts of the posterior lobe such as “pituitrin” contain both the factors, which are also separately available under such trade names as “pitressin” (*vasopressin*) and “pitocin” (*oxytocin*)

ADENOMATA OF THE PITUITARY

The commonest tumour of the pituitary is an adenomatous proliferation of cells of the anterior lobe Such adenomata may be chromophobe, eosinophil or basophil

1 **Chromophobe Adenoma**—Since the chromophobe cells produce no endocrine secretion the only disturbances resulting from a chromophobe adenoma are due to pressure on neighbouring structures Thus the remaining cells of the anterior lobe may be compressed, as indicated by the development of such symptoms as amenorrhœa or impotence The tumour may encroach upon the boundaries of the sella turcica, showing radiographic evidence of generalised enlargement of the pituitary fossa or erosion of the posterior clinoid processes It may enlarge upwards and burst through the diaphragma sellæ, the moment of rupture frequently being associated with intense headache and involve the overlying structures Thus the fibres of the optic nerves which carry impulses from the nasal halves of the retina and cross in the optic chiasma may atrophy, from pressure and lead to bitemporal hemianopia (*vide p 877*) Signs of increased intracranial pressure may develop and an attempt should be made to remove the growth Other suprasellar tumours which may give rise to similar “neighbourhood” symptoms are tumours of the pituitary stalk and cysts of Rathke’s cleft and tumours arising in embryonic rests of Rathke’s pouch, which are known as craniopharyngiomata

2 **Eosinophil Adenoma**—When the tumour develops before the epiphyses have fused there is a generalised skeletal over

growth with the production of *gigantism*. There is seldom a proportionate increase of muscular strength, and the pituitary giant is generally clumsy, feeble and readily fatigued. Development of the adenoma in adult life leads to the condition of *acromegaly*. The onset is usually insidious. Thickening of the soft tissues is as much responsible as actual changes in the carpal and tarsal bones and phalanges for the characteristic enlargement of the extremities. The fingers become clubbed and the hands increase in breadth, giving them a spade like appearance. The gradual changes in the facial appearance finally render the patient unrecognisable to any friend who has not seen him since the onset of the disease. The malar bones, the nose, and the lower jaw become unduly prominent. The lips and tongue are coarsely thickened. The voice becomes rough and deep owing to thickening of the vocal cords and enlargement of the larynx. There is a generalised enlargement of all the viscera—*splanchnomegaly*. The appetite may be voracious and constipation a troublesome symptom. Thirst and polyuria are sometimes observed. Commonly there is a lowered carbohydrate tolerance with transient glycosuria. Usually the sexual functions are ultimately depressed with amenorrhœa and virilism in the female and impotence and loss of libido in the male. Should the tumour increase greatly in size, the pituitary fossa enlarges and 'neighbourhood' symptoms appear. Surgery may be indicated if these become severe. Some success has been achieved by deep X-ray therapy, particularly in relieving headaches and the constriction of the visual fields. No endocrine preparation has been found effective. The disease usually runs a prolonged course and the symptoms are seldom incapacitating or distressing.

Basophil Adenoma (*Cushing's Syndrome*) — Unlike the other types of pituitary adenoma this tumour is usually small and intrasellar and does not give rise to pressure symptoms. It most commonly occurs in young adults or in early middle age. It affects women three times as often as men. The syndrome is characterised by both metabolic and endocrine disturbances. The appetite is ravenous and there is excessive thirst and polyuria. Sugar tolerance is lowered with hyperglycæmia and glycosuria in some cases. Obesity of the face, neck, and trunk, especially of the lower abdomen, is striking and may develop rapidly. Abdominal striae appear, but, unlike those which follow pregnancy, they are purple in colour and do not fade. Extensive ecchymoses are to be seen on the arms and legs and alarming bruises result from trivial injuries. Fractures of the long bones occur from insufficient cause, and

there is frequently osteoporosis of the upper thoracic vertebrae giving rise to kyphosis. The blood pressure is raised and may be extremely high. Headaches, visual disturbances, and suffocative attacks are fairly common. The patient presents a plethoric appearance with polycythæmia. Men suffer from impotence. In women there is amenorrhœa with virilism, hirsuties, acneiform skin lesions and acrocyanosis.

The syndrome may be difficult to distinguish from adrenal virilism, and in every case that has come to autopsy there has been some evidence of increased adrenal cortical activity and in many an adrenal tumour has been found. In some cases there has actually been no evidence of a pituitary adenoma, but in these cases as in all the others a characteristic hyaline degeneration of basophil cells has been found. Treatment is disappointing and transient in its effect. It consists in efforts to check the excessive activity of the basophil cells either by courses of deep X ray therapy to the pituitary gland or by administration of large doses of œstrogens. Surgical removal of the gland has been attempted in a few cases, but it is an heroic procedure which if successful sometimes leads to symptoms of pituitary deficiency such as are seen in Simmonds' disease.

PITUITARY INSUFFICIENCY

1 Simmonds' Disease—This condition develops as the result of a destructive lesion of the pituitary gland, always involving the anterior lobe, and sometimes affecting the posterior lobe as well. The incidence in females is about twice as great as in males, and the syndrome frequently follows pregnancy, post partum hæmorrhage, or abortion. It is due to loss of the stimulating influence of the pituitary on all the endocrine glands. The most striking symptom is the extreme general emaciation. This is associated with muscular weakness. The skin becomes dry and wizened and loses its pigmentation. The teeth and hair rapidly fall out, and one of the characteristic features of the clinical picture is the complete absence of the axillary and pubic hair. There is a loss of sex desire associated with impotence in the male and amenorrhœa and sterility in the female. The basal metabolic rate is usually very low, readings of -60 having been recorded. The temperature is subnormal and the patient is sensitive to cold. The blood pressure is always below normal. Constipation is the rule, and attacks of abdominal pain and vomiting have been described. The abdominal viscera are usually abnormally small (microsplanchnia), in contrast to the condition found in acromegaly. The patient may develop a psychotic state not unlike Korsakow's

syndrome Destructive lesions of the pituitary may of course occur before puberty producing a clinical picture similar to Simmonds disease. At this age the condition is known as *progeria*. The disease is usually but not necessarily rapidly fatal.

Such anterior pituitary or anterior pituitary like preparations as are available may be used in treatment. Weakly potent extracts of the whole anterior lobe growth hormone preparations hardly as yet emerging from the experimental stage as well as chorionic and serum gonadotrophins may be employed but they are seldom more than temporarily efficacious. These extracts are ineffective by mouth and must be given by intramuscular injection.

2 Pituitary Infantilism—This condition which occurs during childhood is seldom fatal and little opportunity has been afforded for examination of the pituitary after death. There is a general retardation of skeletal and bodily growth and the patients remain dwarfed but not deformed. The sexual functions may also fail to develop. There is no mental retardation nor do the patients become obese as is the case in Fröhlich's syndrome. The facial appearance may later become prematurely old and the skin wrinkled. A few cases have been treated with an experimental growth hormone preparation and beneficial results have been reported.

DISORDERS RELATED TO THE PITUITARY AND HYPOTHALAMUS

There is a group of conditions usually described as being due to pituitary deficiency in which the lesion probably lies anywhere on the path between the pituitary and the third ventricle i.e. in the anterior or posterior pituitary in the stalk in the hypothalamus or in the nucleus supra opticus. The commonest of the diseases belonging to this group are Fröhlich's Syndrome and Diabetes Insipidus.

1 Fröhlich's Syndrome (*Dystrophia Adiposo Genitalis*)—The onset of the disease commonly occurs between the ages of eight and ten and is comparatively sudden being marked by a rapid increase in weight which is often accompanied by a cessation or slowing of skeletal growth. The disease may or may not be due to a pituitary tumour and X ray evidence of an enlarged pituitary fossa or calcification of a craniopharyngioma may be found. In those cases which are not due to an organic lesion of the pituitary spontaneous improvement may occur after puberty and it is possible that they represent a com-

parative functional failure of the pituitary at a time when normally a great strain is placed upon it. The condition may also appear for the first time in adult life.

In the male child the penis is small and the testes are undeveloped and may be undescended. The fat is largely deposited around the pelvic girdle, the upper part of the thighs, the lower abdomen, and the breasts, giving the patient a general appearance of a female rather than of a male. The fingers are long and tapering, in contrast to the spade-like hands of acromegaly. The blood sugar tolerance curve may show a diminished rise in the blood sugar level even after the ingestion of very large amounts of glucose, and whereas some normal persons pass sugar in the urine after a dose of 200 grm. of glucose a patient with Fröhlich's syndrome may be able to take 400 grm. without the production of glycosuria. Diabetes mellitus is occasionally an associated condition. Often the subjects of the disease are intellectually bright and do well at school.

The outlook in cases of Fröhlich's syndrome will naturally depend on whether a tumour is present. If this is the case, the "neighbourhood" symptoms may develop and require removal by operation. When the disease is due simply to pituitary hypoplasia or hypothalamic involvement the patient may live for years but owing to the obesity is prone to die of intercurrent infections.

As regards treatment, the available gonadotrophic preparations are sometimes effective but must always be given by injection, preferably twice a week, over a period of months. Unless there is clear evidence of overfeeding or lack of exercise all attempts to reduce the weight by limitation of diet, massage, or exercise usually prove futile, and probably inflict unnecessary hardship on the patient. If a tumour of the pituitary is the cause of the symptoms a radical operation or a decompression may be attempted.

2 *Diabetes Insipidus*—In this condition the main symptoms are polyuria, thirst, and emaciation. The amount of urine is enormously increased and is usually about 20 pints in twenty-four hours. It is of extremely low specific gravity, free from both albumen and sugar. The patient is not inconvenienced by frequency of micturition both by day and night. Sometimes the appetite is excessive, and naturally very large quantities of fluid have to be taken in order to avoid dehydration.

Occasionally the disease has been found to occur in families.

The condition may last for many years without fatal effects, and treatment by extract of the posterior lobe is often effective. Subcutaneous injections of pituitrin produce a marked diminution in diuresis, which lasts for six to twelve hours. For effective treatment it is usually necessary for the patient to have two injections a day of $\frac{1}{2}$ to 1 cc of the extract. Such doses may, however, produce unpleasant symptoms due to intense peripheral vasoconstriction and intestinal peristalsis. Unfortunately, oral administration, either of the extract or of the dried glands is completely without effect. A dried powder of the posterior lobe may be used as a snuff and is effectively absorbed. This form of treatment has the advantage that smaller doses may be given at more frequent intervals. If the diuresis fails to react to injections of extract the lesion is probably in the hypothalamus rather than in the pituitary itself.

The polyuria in diabetes insipidus is due to a failure of the epithelium of the renal tubules to reabsorb chlorides and water. If, therefore, a drastic restriction is imposed on the chloride intake diminution of the volume of urine results.

The disease is readily distinguished from diabetes mellitus by the glycosuria in the latter. Chronic interstitial nephritis may produce marked polyuria and frequency, but albuminuria, a raised blood pressure, and cardiac hypertrophy will decide the diagnosis. In hysteria, polyuria occurs, but is purely transient.

P M F BISHOP
J J CONYBEARE

DISEASES OF METABOLISM

DIABETES MELLITUS

THE amount of glucose in the blood remains remarkably constant in healthy persons, and is expressed either in milligrammes per 100 c c of blood or in grammes per cent. When fasting, the blood whether arterial or venous, contains between 80 and 120 mgm per 100 c c (0.80 to 1.20 per cent). Even an hour after large amounts of carbohydrate it rarely rises above 170 mgm and is usually less, and within two hours it has fallen to the fasting level.

The relative stability of the blood sugar is effected by the interaction of many factors, which may be considered separately.

1 *The Pancreas*—The internal secretion of this organ, produced by the *islets of Langerhans* and known as insulin, is the most important factor in the regulation of the blood sugar. There is a steady and continuous production of insulin by the healthy pancreas, and in addition its output is increased when food, particularly carbohydrate, is taken. The exact mode of action of insulin is incompletely understood, but it probably renders the glucose in the blood available for storage as glycogen in the liver and the muscles. Thus if the output of insulin is insufficient the blood sugar is increased, and when it reaches a level of approximately 180 mgm per 100 c c sugar passes through the kidneys and is excreted in the urine. This level of blood sugar is usually described as the *renal threshold*. When the blood sugar is below the renal threshold the urine contains no sugar, when it is above it glycosuria is present. The importance of the renal threshold is discussed later in connection with renal glycosuria.

2 *Liver*—This organ is the main site not only for storage of glycogen but for its delivery to the blood and tissues. If the liver is removed in an experimental animal the blood sugar rapidly falls to very low figures and the animal dies in hypoglycæmic convulsions. If adequate glucose is injected intravenously the blood sugar rises and the animal recovers rapidly. This experimental work on hepatectomised dogs first gave the clue to the elucidation of the symptoms of hypoglycæmia.

in man (*vide p 306*) In clinical practice hypoglycæmia as a result of liver dysfunction is almost unknown as the extent of damage to the organ has to involve practically the whole liver

3 *Pituitary Body*—The hormones produced by the pituitary, especially those of the anterior lobe oppose the action of insulin and raise the level of blood sugar Although hyperactivity of the pituitary through its diabetogenic hormone may raise the blood sugar and produce glycosuria it is unlikely that this gland plays an important part in diabetes mellitus

4 *Adrenals*—The internal secretion of the adrenal medulla (adrenalin) stimulates the conversion of glycogen in the liver into glucose hence the value of adrenalin in the treatment of hypoglycæmia (*vide p 308*) The hormone secreted by the adrenal cortex opposes the action of insulin and under certain circumstances may produce hyperglycæmia The part played by the adrenals in the ætiology of diabetes is probably small

5 *Thyroid*—Excess of thyroxin aggravates the severity of diabetes and a diminution of thyroid activity lowers to some extent the level of blood sugar

Pathogenesis of Diabetes—Although as has been shown above the liver and endocrine glands probably play a part in the control of the blood sugar the most important factor in the development of diabetes is the pancreas Thus the experimental ablation of that organ produces the disease Additional proof is the fact that insulin the internal secretion of the pancreas can rectify the metabolic anomalies of diabetes It is true that there are no constant post mortem findings in the pancreas of diabetics The reserve of the healthy pancreas like that of other vital organs such as the liver and kidneys is very great and probably at least seven eighths of the gland must be destroyed before diabetes develops It is not surprising, therefore that growths of the pancreas or even more widespread lesions such as acute pancreatitis rarely produce diabetes Hæmochromatosis (*vide p 462*) alone of diseases involving the pancreas almost invariably produces diabetes

It is probable that diabetes more often results from one or both of the following factors (i) an inherent insufficiency in the islet tissue or insular reserve (ii) disturbances of metabolism which make additional demands on the islet cells The first factor, inherent insufficiency in the insular reserve is often inherited and probably accounts for the frequency of familial and racial diabetes The main disturbance of metabolism which produces diabetes is obesity The majority of diabetics who develop the disease in middle or later life have been much

overnight this throws an extra strain on all the organs including the pancreas. Less often hyperthyroidism especially if long continued may produce diabetes.

Although the metabolic disturbance in diabetes mellitus primarily involves carbohydrate metabolism the disease at any rate in its more severe forms, if untreated interferes with the metabolism of fat and protein in addition. The abnormal breakdown of fats produces an excess of ketone bodies. *B* *o* *v* butyric acid acetoacetic acid (diacetic acid) and acetone. Their accumulation in the blood gives rise to the clinical picture of ketosis and diabetic coma (*vide p. 312*) and they are also excreted in the urine and through the lungs. In severe diabetes untreated with insulin the patient may excrete far more sugar than the amount of carbohydrate taken in the food and this surplus is produced by the conversion into glucose of protein and to a less degree of fat. If insulin and carbohydrate are given ketosis is abolished.

Symptoms and Diagnosis of Diabetes Mellitus—In mild diabetes symptoms may be completely absent for years although glycosuria may be continuously present. In more severe cases thirst polyuria and loss of weight are prominent features. The irritation of the glucose in the urine often causes *h* *a* *m* *i* *n* *i* *t* *i* *s* or pruritus of the vulva. With severe diabetes and ketosis the tongue becomes dry red and painful and there may be general dehydration of the tissues. The urine contains glucose often up to 5 per cent and ketone bodies may also be present. Although it is true to say that all untreated diabetics pass sugar it cannot be assumed that the finding of glucose in the urine necessarily indicates diabetes. Actually this is very far from the truth and many patients have been subjected to unnecessary hardship by the unwarranted diagnosis of diabetes on the strength of glycosuria alone. Diabetes can be diagnosed with certainty when typical symptoms such as polyuria thirst and wasting are present in conjunction with glycosuria. When the only grossly abnormal finding is glycosuria a full investigation is essential. The point at issue can be settled with certainty by the *b* *l* *o* *o* *d* *-* *s* *u* *g* *a* *r* *t* *o* *l* *e* *r* *a* *n* *c* *e* *c* *u* *r* *v* *e*. The patient should have been taking a normal mixed diet for some days without restriction of carbohydrate. Having eaten no breakfast he empties his bladder and has a blood sugar estimation done. This gives the fasting blood sugar level. He then takes 50 mgm of glucose dissolved in approximately 100 cc of cold water flavoured with lemon. Further blood sugars are done at half hourly intervals for two and a half hours. A normal person will have a fasting blood sugar ranging from 80 to 120 mgm per

100 c c, while that in a diabetic will tend to be considerably higher. In fact a fasting blood sugar of over 130 mgm is presumptive evidence of diabetes. Diabetic and normal blood sugar tolerance curves are shown in Fig 5. It will be noted that in the normal person though the blood sugar may rise to 170 mgm or even over in the first hour after the ingestion of glucose, it falls rapidly and within one and a half to two hours it is down to or below the fasting level. A diabetic, however,

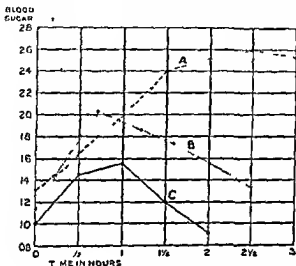


FIG 5—A, Curve from Severe Diabetic B, Curve from Mild Diabetic, C, Normal Curve

behaves very differently. The rise of blood sugar is very prolonged and at the end of two hours it has quite failed to approximate to the fasting level, and, at any rate, in diabetes of moderate severity it may remain very high for hours. While the blood sugar is above the normal renal threshold or "leak point," which is usually about 170 mgm, sugar is present in the urine.

In so called *renal glycosuria* glucose passes through the kidneys at blood sugar levels well below the normal leak point. In such cases, although sugar may be more or less constantly present in the urine, the blood sugar curve is perfectly normal. Renal glycosuria produces no symptoms and calls for no treatment.

A further group of cases has been described by Maclean under the term "lag curve." An example of this is given in Fig 6. It will be observed that the blood sugar rises rapidly to a point much in excess of the normal, but the fall to normal

is equally abrupt and is complete within two hours. Sugar is passed in the urine during the period when the blood sugar level is above the normal renal leak point. Macleod suggested that there is a delay or lag in the action of the sugar storage mechanism but the rapid rise in blood sugar is more probably due to rapid absorption from the intestine in persons whose stomachs empty unusually fast. Glycosuria of the 'lag curve' type is not uncommon following gastro jejunostomy.

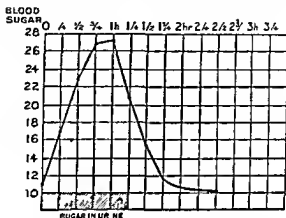


FIG. 6 — Lag Curve

None of the symptoms of diabetes are present and there does not appear to be any special liability to develop the disease. Occasional urine examinations and blood sugar estimations should be carried out in order that early warning of any change in the type of glycosuria may not be overlooked.

Transient glycosuria is not uncommon in healthy persons as the result of excitement such as a life insurance examination. Cannon and Fiske found that out of twenty five members of the Harvard University football team no fewer than twelve had glycosuria after the Harvard *versus* Yale match. That excitement and not exertion was responsible is proved by the fact that five out of the twelve who had glycosuria were acting as reserves and did not actually take part in the game. Such glycosuria is purely temporary and is due to stimulation of the suprarenals. A head injury or generalised convulsions such as epilepsy may lead to similar transient glycosuria.

Examination of Urine for Sugar and Ketones—This is of such paramount practical importance that the details of the tests are summarised briefly below —

1 *Fehling's Test*—Equal amounts of Fehling's solution and urine are boiled in separate test tubes and while boiling

are mixed. The mixture is brought back to boiling point momentarily. If sugar is present the liquid becomes turbid and the colour changes to green or red. Fehling's solution is reduced to some extent in a concentrated urine by creatinine or uric acid.

* 2. *Benedict's Test*.—Eight drops of the urine are run into a clean test tube and 5 c.c. (one teaspoonful) of Benedict's qualitative solution added. The mixture is then boiled for two minutes. If sugar is present the solution becomes turbid and changes colour to green, yellow, or red according to the quantity of sugar present.

The fact that the reducing body is glucose can be proved by the preparation of an osazone or by fermentation tests with yeast.

Tests for Ketone Bodies.—These are most important, as from the point of view of treatment the presence of ketones is even more important than is that of sugar.

1. *Rothera's Test*.—About 10 c.c. of urine are saturated with crystals of ammonium sulphate, and a few drops of a freshly prepared solution of sodium nitroprusside added. The solution is then made alkaline with strong ammonia. A purple colour develops if ketones are present.

2. *Gerhardt's Test*.—About 10 c.c. of the urine are placed in a test tube and a 10 per cent. solution of ferric chloride is added drop by drop. A white precipitate of phosphate forms and redissolves, and if diacetic acid is present the colour of the solution becomes red.

Rothera's test is very delicate and unless the purple colour is deep and develops rapidly, it does not necessarily indicate a dangerous ketosis. A strongly positive Gerhardt test, on the other hand, is a danger signal. If the patient has been taking aspirin or salicylates, the urine becomes purple or violet in colour with ferric chloride, which may obscure the red colour due to ketones. The Rothera test is unaffected by these drugs.

Complications of Diabetes.—These are numerous and important. In fact, since the advent of insulin diabetic complications are more potent factors in morbidity and even in mortality than the diabetes itself. Diabetic coma is dealt with elsewhere (*vide p. 312*).

1. *Boils and Carbuncles*.—These are relatively common, especially in mild untreated diabetes. In all such cases the urine should be tested for sugar. Large carbuncles are always especially dangerous in diabetics as they may precipitate ketosis and coma.

2. *Peripheral Neuritis*.—This is described on p. 938.

3 *Gangrene*—Elderly diabetics are specially prone to develop gangrene of the toes or feet. This serious complication is very rare before the age of 50 and except in the very aged it seldom is seen until five or more years after the diagnosis of diabetes has been made. Diabetic gangrene is always associated with atheroma of the vessels but this is liable to occur at an earlier age in diabetic than in non-diabetic patients.

There are two factors which lead to gangrene in diabetics: (1) impairment of the blood supply owing to arteriosclerosis, (2) diminished resistance of diabetic tissues to trauma and infection. The extent to which the circulatory factor is operative may be judged from the presence or absence of pulsation in the dorsalis pedis and posterior tibial arteries. Pain is often very severe and the gangrene may be moist or dry.

The decision as to whether amputation is necessary is often a very difficult one. If the gangrene is spreading rapidly, and no arterial pulsation can be felt, immediate amputation is required. When, however, there is much infection of the tissues and particularly when undrained pus is present, more conservative measures are justifiable. Collections of pus should be drained and the wound irrigated with Dakins or other antiseptic solution. It is frequently found that healing may take place in a few months, particularly if the diabetes is controlled with insulin. Persistent and severe pain associated with gangrene is an indication for early amputation.

4 *Pulmonary Tuberculosis* (vide p 315)

5 *Ocular Complications*—Cataract is common in elderly diabetics as is diabetic retinitis, especially in arteriosclerotic patients.

6 *Xanthochromia and Xanthoma Diabeticorum*—Xanthochromia is a yellowish discoloration of the skin especially on the face and palms of the hands. It is due to carotene and lipochrome pigments. Its occasional appearance in diabetics is probably due to large amounts of vegetables in the diet.

In xanthoma diabeticorum numerous bright yellow tumours appear on the skin. There is usually a high blood cholesterol. The condition is chiefly seen in severe diabetics.

Types of Diabetes and Prognosis—Diabetes may appear in every grade of severity from a symptomless glycosuria to a fulminating type of the disease in which coma is the first symptom. Speaking generally the younger the patient the more severe and acute the diabetes though this is by no means invariably true. On the whole familial and hereditary diabetes tends to be mild or moderate in severity. The great majority of diabetics can be maintained in perfect health and vigour

by insulin and during the past twenty years as a result of the discovery of insulin diabetes has now become a nuisance rather than an incertainty. Needless to say, except in its mildest forms, the prognosis of the disease depends almost entirely on the patient. Consistent disregard of either diet or insulin will lead to serious deterioration or even death. Diabetes in children is described on p 310, as are the effects of pregnancy (*vide* p 315).

Diabetes in elderly persons is usually benign in its course and seldom calls for more than qualitative dietetic restrictions. If associated with arteriosclerosis gangrene (*vide* p 298) may be a dangerous complication.

TREATMENT OF DIABETES

In the treatment of diabetes, either with or without insulin, four general principles must be fulfilled.

1 The patient must be given a diet which is adequate in caloric value to enable him to carry on a useful and active life and yet avoid over nutrition. Though occasional glycosuria is inevitable the passing of large quantities of sugar must be prevented.

2 His diet must be so balanced in regard to content of protein carbohydrate and fat that he does not develop ketosis.

3 The diet must be so arranged that it conforms as closely as possible with that of normal individuals.*

4 If treated with insulin the dosage must be regulated to avoid so far as is possible both hyperglycemia and insulin reactions (*vide* p 306).

As regards the first of these principles, it is obvious that the caloric requirements of individuals must vary widely, depending on their age, sex, size, and occupation. Infants and children require diets of a relatively high caloric value to allow for growth as well as for the normal metabolic requirements. Women need about 10 per cent fewer calories than do men. With increasing age caloric requirements decrease. Persons engaged in heavy manual work require larger diets than those in sedentary occupations. The terms "basal" and "maintenance" diets are often used. A 'basal' diet is one which will provide an adequate number of calories for a person at complete rest, a 'maintenance' diet is one containing sufficient calories for an ordinary active life. A "maintenance"

* War time restrictions have increased difficulties of diet for diabetics. Patients are advised to join the Diabetic Association 124 Baker Street London W 1. The Association publishes a journal of great value to diabetics particularly during war.

diet contains about 30 per cent more calories than a "basal diet." From a practical point of view, however, the "maintenance diet" is of chief importance, as the diabetic must be able to lead a life of unrestricted activity. For adult patients it is generally sufficient to allow 35 to 40 calories to each kilo of body weight. Thus between the ages of twenty and fifty the following figures may be regarded as adequate for an ordinary sedentary life calling for no manual work —

Weight.	Caloric Requirements.
10 stones	2 500
11 "	2 800
12 "	3 100

For female patients about 10 per cent of the calories may be deducted. The caloric requirements of children are discussed elsewhere (*vide p. 310*).

Needless to say the nutritional state of the patient will have an important bearing on the caloric content of the diet. If the patient is emaciated the diet must be relatively high, whereas in a diabetic already much overweight a lower diet is advisable. As a check upon the caloric value of the diet a careful record of the patient's weight should be kept from week to week. A steady and continued increase in weight, except in emaciated persons, is most undesirable, while a steady loss of weight indicates in most cases that the diet is too low.

The second general principle is that the patient should be given a diet on which he does not develop ketosis. Fortunately with the aid of insulin it is now possible to allow every diabetic sufficient carbohydrate in relation to the quantity of fat in the diet to prevent the formation of ketone bodies.

The amount of protein in the diet must be adequate to replace the constant breakdown of tissue protein. This should be in adults at least 1 gram of protein to each kilo of body weight. Probably no harm is done if this is increased somewhat especially in those leading active and energetic lives, but it should rarely exceed 100 gram. High protein diets tend to render stabilisation with insulin difficult. With children and adolescents proportionately larger amounts of protein are required to allow for growth (*vide p. 311*).

The carbohydrate content of the diet necessarily varies with the age and sex of the patient, but for an adult who is leading a normal active life not less than 150 gram should be allowed, and it is probably preferable in most cases to give up

to 180 grm. More than this can rarely be taken except with insulin (*vide* p. 304). The amount of fat allowed to a diabetic depends on the caloric requirements, but high fat diets with a relatively low carbohydrate content are both unpalatable, expensive, and tend to produce ketosis.

The third general principle in the construction of a diabetic diet is that it should conform as closely as possible to the type of diet eaten by healthy persons. This not only saves expense and trouble in the household, but it enables a diabetic to play his part in social life and prevents the development of an inferiority complex. Special diabetic foods should never be necessary.

Bearing in mind what has been said above, we may now proceed to consider the treatment of patients suffering from diabetes. However obvious the diagnosis may be, it is most important to make a thorough physical examination before the institution of treatment. This may reveal the presence of other pathological conditions such as tuberculosis, arteriosclerosis and heart disease, cholecystitis or gall stones, focal sepsis in teeth or tonsils, all of which have a bearing on the treatment of the diabetes.

Needless to say, the line of treatment to be adopted in individual cases will vary with the severity of the disease, and the first question which usually needs decision is whether the patient should start on insulin at once, or whether dietetic treatment alone should be tried to begin with. There are four indications for starting insulin immediately: (i) coma or incipient coma, (ii) the presence of considerable ketosis as indicated by a positive Gerhardt test (*vide* p. 297), (iii) complications such as phthisis or the necessity for a surgical operation, (iv) emaciation, where the patient obviously requires a high caloric diet. If none of the above conditions are present, it is usually justifiable—except perhaps in infants and children—to test the patient's reaction to undernutrition diets. Starvation is never necessary, as it not only submits the patient to unnecessary hardship, but it also often produces ketosis as the patient during starvation is really living mainly on his own body fat. Below are given three test diets containing respectively approximately 950, 1,200 and 1,550 calories. In all of them the fat is sufficiently restricted to inhibit ketosis. The patient should be first of all placed on No. 1 diet, and its effects noted on the excretion of sugar over a period of five to seven days. If on this relatively low diet, sugar does not either disappear or become very greatly diminished, it is obvious that insulin will be required. During the period of the test

specimens of urine should be obtained four times a day and the results carefully recorded on a chart such as that on p 303. Such a chart enables the progress of the case to be seen at a glance.

If on diet No. 1 the patient becomes sugar free he may be put on to No. 2 and later No. 3 provided he remains sugar free. Later the diet may be built up with further gradual additions of carbohydrate and fat in equal amounts until an adequate maintenance diet is reached. It is important that the carbohydrate in the diet should be more or less evenly distributed throughout the day.

Quite apart from the dietetic treatment of diabetes, careful attention must be paid to the general health of the patient, particularly as regards focal sepsis. In the presence of an infection insulin, both endogenous and exogenous, works inefficiently. The teeth should be X-rayed and any which may be septic removed. If the tonsils show signs of chronic infection tonsillectomy should be performed. Elderly diabetics should pay particular attention to the feet; these should be washed daily, carefully dried, and sprinkled with boracic powder. Shoes must be large and not rub the toes. Neglect of these precautions increases the liability to gangrene. The bowels should be kept open regularly. Mental worry and anxiety must be avoided. Although it is never justifiable to promise a cure, it may be pointed out that diabetics who adhere carefully to the instructions given to them may live a practically normal and useful life for an indefinite period.

DIABETIC TEST DIETS

APPROXIMATE FOOD CONTENT

No. 1		No. 2.		No. 3.	
Protein	70 grm.	Protein	70 grm.	Protein	75 grm.
Carbohydrate	80 "	Carbohydrate	100 "	Carbohydrate	100 "
Fat	40 "	Fat	60 "	Fat	95 "
Calories	950	Calories	1,200	Calories	1,500

Breakfast	Breakfast	Breakfast
1 egg	½ grape fruit or 1 small orange	1 oz. oatmeal (dry weight).
Tomatoes		2 oz. cream
2 oz. milk.	1 egg	1 egg
1½ oz. bread	1 oz. bacon	1½ oz. bacon.
	Tomatoes	Tomatoes.
	2 oz. milk	2 oz. milk
	1 oz. bread	1 oz. bread.

Lunch	Lunch	Lunch
3 oz meat or fish Green vegetables (5 per cent group) 1 small orange	3 oz meat or fish Green vegetables (5 per cent group) $\frac{1}{2}$ oz cheese $1\frac{1}{2}$ oz bread	3 oz meat or fish Green vegetables (5 per cent group) $\frac{1}{2}$ oz cheese $1\frac{1}{2}$ oz bread $\frac{1}{2}$ oz butter
Supper	Supper	Supper
Clear soup 3 oz meat or fish Green vegetables (5 per cent group) 3 oz potatoes 1 oz cheese $1\frac{1}{2}$ oz bread Coffee (black) or tea	Clear soup 3 oz meat or fish Green vegetables (5 per cent group) 3 oz potatoes (boiled) 1 small orange 1 egg Coffee 1 oz cream	Clear soup 3 oz meat or fish Green vegetables (5 per cent group) 3 oz potatoes 1 small orange 1 egg Coffee 1 oz cream

NOTES.—The vegetables and fruits in the 5 per cent group (*vide p. 303*) may be taken as desired as their food value is low. All other food should be carefully weighed until the patient has become experienced in estimating weight. Clear soup, tea, coffee, have no food value and may be taken as desired. No alcoholic beverages and no special diabetic foods may be taken without the doctor's permission. When fish is taken instead of meat $\frac{1}{2}$ oz of butter may be added.

URINE CHART

The urine should be tested four times daily with Benedict's qualitative solution (*vide p. 297*) and the results charted as follows —

Blue and clear	0
Green and turbid	+
Yellow and turbid	++
Red brown and turbid	+++

Insulin	Date.	Early Morning Specimen	Noon Specimen	6 P.M. Specimen	10 P.M. Specimen	Notes
5	5	1st	+++	+++	+++	Rothera +
10	5	2nd	++	+++	++	Rothera ±
10	10	3rd	+	++	+	Rothera —
15	10	4th	+	0	+	
15	15	5th	0	0	++	0
15	15	6th	0	0	+	0
						Reaction 11 30 P.M. $\frac{1}{2}$ oz sugar taken
15	12	7th	0	0	0	0

Insulin Treatment—Insulin is now available commercially in two forms, (a) soluble insulin, which is an acid solution of insulin hydrochloride with a maximum action within two to four hours after injection, and (b) zinc protamine insulin, an alkaline suspension, which acts much more slowly (*vide p 305*). Insulin is standardised in units by its effect in lowering the blood sugar in rabbits. Soluble insulin is supplied commercially in three strengths, 20, 40, and 80 units in each cubic centimetre. These strengths are often described as "single," "double" and "quadruple." As a rule with doses up to about 12 units 'single' strength insulin is used and with larger doses one or other of the more concentrated varieties. On deciding that insulin is necessary, the best plan is to start with two injections of 5 units each, one given half an hour before breakfast and the second half an hour before supper. The patient is put on an approximately basal diet—No. 3 test diet is usually adequate for the average adult. If the patient is under observation in a hospital or nursing home, it is safe to increase the insulin by daily additions of 5 units, the first increase being made in the morning. Thus on the first day the patient takes 5 units morning and evening, on the second day 10 units in the morning and 5 in the evening, on the third day 10 units morning and evening, on the fourth day 15 units in the morning and 10 in the evening. If the patient is under treatment at home it is safer to increase the dosage more gradually. As stabilisation proceeds the dosage of insulin will have to be regulated according to the time of day that glycosuria or hypoglycæmic reactions occur. In a few cases a third dose of soluble insulin may be necessary before lunch. If there is considerable ketosis the initial doses of insulin should be larger and the amount of fat in the diet should be reduced by 50 per cent.

When an uncontrolled diabetic is brought under the influence of insulin there is often a sudden alteration in the eyesight, which may render reading difficult. This is due to refractive changes in the lens resulting from changes in the water balance of the body. The vision rapidly returns, though new glasses may be necessary.

Occasionally allergic reactions develop at the site of injection forming red and indurated areas, which are sometimes tender. These usually cease to occur after a few days. If they do not a change of the brand of insulin to one made from a different animal, e.g. pig may be effective.

While stabilisation on insulin is being carried out the urine should be tested four times a day and the results carefully

charted. Increases in insulin are controlled mainly by the urinary sugar. When this disappears or becomes very small in amount the dose of insulin should be increased very gradually. Blood sugar estimations are of little value while the urine contains sugar, but when this has disappeared, they help to control treatment. The blood should be drawn either shortly before the morning or evening injection of insulin, as at these times the readings are likely to be at their maximum.

When the patient has been stabilised on a basal diet, further increases in the diet must be made in order to raise it to a maintenance level. Sometimes no additional insulin is required, but if glycosuria recurs the amount of insulin should be gradually increased. When soluble insulin is being given it is advisable that the bulk of the carbohydrate should be taken in the meals following the injections of insulin.

Opinions differ considerably as to the amount of carbohydrate which should be included. There is general agreement that a very low carbohydrate ration (e.g. 50 gm per diem) is undesirable, as it renders the patient specially liable to ketosis, and is also unpalatable. Moreover, on a low carbohydrate diet patients feel less fit and less energetic than when larger amounts are allowed. Rabinovitch and others advocate extremely large amounts of carbohydrate, even up to 300 gm a day. On such a diet the amount of fat has to be restricted very severely, or the patient will be found to be taking an over nutrition diet. Probably it is best to give between 150 and 180 gm of carbohydrate daily. This allows an adequate amount of fat to be included. Diabetics doing heavy manual work will of course need a diet containing more carbohydrate and a high caloric content.

Zinc Protamine Insulin—As a result of work by Hagedorn and Scott an insulin has been produced, the action of which is more prolonged than is the case with ordinary insulin. Whereas the latter controls the blood sugar for only about four to five hours, the new product—often known as Z P I or P Z I—has a far longer duration of action, probably up to twenty four hours or more. Moreover, zinc protamine insulin is less precipitate in its action. This is due to the fact that it is more slowly absorbed from the site of injection than is ordinary soluble insulin.

Diabetics of only moderate severity, particularly those over forty years of age, can usually be controlled by a single morning injection of Z P I, but severe diabetics may need both kinds of insulin, soluble to control glycosuria after breakfast and protamine zinc to control the diabetes during the

later part of the day and during the night Soluble insulin and Z P I are best injected separately, using two syringes. The same needle may be used if the injection site is altered by moving the needle under the skin.

Zinc protamine insulin, though more slowly absorbed than soluble insulin, is liable to produce severe hypoglycæmic reactions which sometimes come on insidiously, so that the patient may have no initial warning symptoms. Consequently it is important that the dose of Z P I should be increased gradually, and patients who are being stabilised on this insulin should preferably be under control and observation in a hospital or nursing home.

During stabilisation of patients on zinc protamine insulin the diet should be maintained at a constant level with approximately 150 gm of carbohydrate a day. The carbohydrate should be spread evenly throughout the main meals and a small carbohydrate feed at bedtime is required. For a patient who has not had insulin previously, an initial morning dose of 10 to 20 units, according to the severity of the diabetes, is advisable, and the dose can be increased by 6 units every fourth morning until absence of glycosuria or low blood sugar readings indicate that the dose is sufficient. When a patient who has previously been taking two doses a day of ordinary insulin desires to change over to zinc protamine, the best plan is to give him his ordinary morning dose of soluble insulin and in addition the same number of units of zinc protamine as he has been accustomed to take of soluble insulin in the evening. The dose of soluble insulin is then gradually cut down and that of zinc protamine increased until stabilisation has been effected. As has been stated above, it is sometimes necessary to give both types of insulin indefinitely.

The advantages of zinc protamine insulin are that in most diabetics of moderate severity a single daily injection replaces two injections of soluble insulin, and its slower absorption diminishes the fluctuations in blood sugar which sometimes occur in patients taking soluble insulin. It is rarely desirable to give doses of more than 40 units of zinc protamine insulin.

Owing to its relatively slow absorption zinc protamine is less effective than soluble insulin in urgent conditions such as diabetic coma or when coma appears to be imminent. At the present time zinc protamine insulin is available in "double strength" and "quadruple strength" forms, i.e., 40 units and 80 units to 1 c.c.

Hypoglycæmic Reactions—When insulin lowers the blood sugar below about 65 mgm per 100 c.c., characteristic symptoms are produced, which are usually termed hypoglycæmic

or insulin reactions. The blood sugar level at which these occur varies considerably in different patients. The initial symptoms of a reaction are tremor, sweating, and a sensation of hunger or a sinking feeling in the epigastrium. When the blood sugar falls there is probably increased activity of the suprarenals in an attempt to mobilise glucose from the tissues. This may readily produce the above symptoms as side effects. The patient also may become confused, agitated, noisy, hilarious or quarrelsome. Sometimes acute alcoholism is closely simulated and in some cases hypoglycæmic patients have even been arrested as being intoxicated. In more advanced hypoglycæmia there may be twitchings, paralyses, convulsions, and coma. Reactions are most likely to occur two to four hours after an injection of soluble insulin but sometimes they may be delayed for eight hours or more.

The factors which are likely to produce reactions in a patient taking insulin are as follows —

- 1 Errors in measuring the dose or the inadvertent use of double or quadruple strength insulin
- 2 Increase in carbohydrate tolerance after stabilisation
- 3 After recovery from infections or sepsis, both of which conditions produce a temporary decrease of carbohydrate tolerance
- 4 Delay or omission of a meal after an injection of insulin
- 5 Gastro intestinal disturbances which interfere with the absorption of carbohydrate
- 6 Unaccustomed physical exercise, especially if prolonged. This is probably due to depletion of the stores of glycogen in the liver

Hypoglycæmia due to zinc protamine insulin often gives little warning of its onset owing to the gradual but prolonged fall in the blood sugar level. The prodromal symptoms of sweating and tremor are usually absent and continued headache and malaise may be prominent features. Coma due to zinc protamine insulin reacts to treatment less readily than that due to soluble insulin and even when consciousness has been regained relapse into coma is not uncommon, unless the administration of glucose is continued.

Hypoglycæmia following soluble insulin is rarely confused with diabetic coma and the differential diagnosis is discussed elsewhere (*vide p 313*). Treatment is simple if the patient realises the significance of the symptoms in the early stages. Every diabetic taking insulin should carry with him a few

lumps of sugar as an insurance against emergencies. One or two lumps, preferably taken with a little water will rapidly cut short a reaction. In more severe cases where the patient is unconscious 10 to 20 gm of glucose should be given intravenously or a stomach tube may be passed and 50 gm of glucose dissolved in a few ounces of water introduced. Hypodermic injection of 10 minims of 1 in 1 000 solution of adrenalin repeated if necessary will usually restore consciousness sufficiently to enable sugar to be taken by mouth.

In rare instances *spontaneous hypoglycæmia* has been recorded in patients with a carcinoma or adenoma of the islets of Langerhans in the pancreas which produces an excess of endogenous insulin. The symptoms are similar to those of reactions due to exogenous insulin but become progressively more severe and intractable. In a few instances the condition has been cured by surgical removal of such an adenoma.

The occurrence of hypoglycæmic reactions in a patient undergoing stabilisation on insulin usually indicates that the dose of insulin is too high. Rather smaller doses should be given but insulin should not be completely omitted. Special caution should be exercised to avoid reactions in elderly patients. This is most important in patients with a degenerated heart muscle, as a severe reaction may cause anginal attacks or even sudden death. Young children and very emaciated diabetics are specially prone to hypoglycæmia and in them increase in insulin dosage should be very carefully graduated. In such cases if facilities are readily available for blood sugar estimations these are helpful in enabling the medical attendant to gauge the effect of insulin.

Glycosuria and Hypoglycæmia—Although the ideal to be aimed at in the treatment of diabetes is a normal blood sugar and absence of glycosuria throughout day and night the ideal can rarely be attained completely in any diabetic who needs insulin without the risk of hypoglycæmia. There is little evidence that at any rate a transient rise in the blood sugar above the renal threshold (170 mgm per 100 cc) is harmful and it is certainly better that sugar should occasionally be passed in the urine than that the patient should be subjected to the discomforts, risks or even dangers of hypoglycæmia. Even without the development of definite hypoglycæmic symptoms many patients find that they feel tired and generally unfit if an attempt is made to keep them continuously free from glycosuria. No attempt should therefore be made to maintain a sugar free urine if this involves insulin reactions for the latter are certainly more incapacitating and

perhaps even more damaging than moderate glycosuria. Increase of the carbohydrate ration may abolish reactions without cutting down the insulin. It is of course essential to prevent ketosis.

Education of the Diabetic Patient—If a diabetic patient is to be treated satisfactorily, it is essential to obtain his intelligent co-operation, or at any rate that of his relatives. In order to adhere to his diet the patient must learn the elements of dietetics, and it is equally important that he should become adept at testing his urine, and, if necessary, giving himself insulin. The wide recognition of the necessity for the education of diabetic patients has led to the publication of many diabetic manuals both in this country and in America, one of which the patient should be made to study as soon as treatment is commenced.

For the control of diabetic treatment especially while the patient is being stabilised on insulin, the urine needs to be tested at least four times daily. This can be done more conveniently, and certainly more cheaply, by the patient himself than by the medical attendant and therefore at the beginning of treatment the patient should be taught to test his urine. The most reliable test is Benedict's qualitative test, from the colour of the solution it is easy to judge roughly the amount of sugar present, provided a standardised technique is used (*vide p 297*). If the patient is taking insulin the injections should be given by the patient himself from the beginning. He should be warned to avoid repeated injections into the same area of skin as this may produce localised atrophy known as *insulin fat atrophy*. As regards diet all foods except the 5 per cent vegetable group should be weighed until the patient learns to judge the size of a given portion with reasonable accuracy. In order to avoid monotony in diet the patient must have a knowledge of the content of various foods in common use as regards pretem carbohydrate and fat in order that he may be able to vary his diet.

All vegetables and fruits contain carbohydrate and they are classified as follows, according to the percentage of carbohydrate present in their fresh state. Tinned vegetables have approximately the same carbohydrate content, but tinned fruits must be forbidden owing to the syrup in which they are preserved.

5 per cent vegetables and fruits grape fruit cabbage lettuce, cucumbers spinach, asparagus marrow, celery, tomatoes watercress leeks Brussels sprouts cauliflower mushrooms, rhubarb, scarlet runners,]

10 per cent *vegetables and fruits* oranges strawberries
black currants gooseberries blackberries pumpkins
turnips beets carrots onions

15 per cent *vegetables and fruits* plums apricots apples
pears cherries raspberries green peas artichokes
parsnips

20 per cent *vegetables and fruits* bananas prunes potatoes
haricot beans boiled rice boiled macaroni

Other sources of carbohydrate are (i) oatmeal which contains about 66 per cent of carbohydrate when weighed dry (ii) bread which whether white or brown contains approximately 50 per cent of carbohydrate (iii) milk

The 5 per cent group of green vegetables and fruits contain so little utilisable carbohydrate that they may be taken in an unrestricted amount even by severe diabetics. All other groups must be taken only in such amounts that the total carbohydrate ration is not exceeded.

Quite apart from the regulation of the amount of carbohydrate in the diet it is important that the total caloric value shall not be increased by too large amounts of protein and fat. If these are unrestricted not only will the patient become obese but he is likely to develop ketosis.

The consumption of alcohol in anything except very limited amounts should be forbidden as diabetics readily develop alcoholic neuritis. Many alcoholic beverages contain much sugar particularly liqueurs port dark sherry and heavy beer or stout. These should be avoided completely but spirits light clarets dry hocks and ordinary bitter beer are relatively innocuous.

In calculating the caloric value of foodstuffs it is essential to know that for practical purposes 4 calories are produced by 1 gram of protein or carbohydrate and 9 calories by 1 gram of fat. A table is given on the following page showing the food content of some of the common foodstuffs. For more detailed dietetic tables manuals on diabetes should be consulted.

Diabetes in Infants and Children—Usually though not invariably diabetes starting before the age of 20 is severe in type and before the discovery of insulin few diabetic children survived more than two years. Fortunately with adequate treatment diabetic children now grow up normal in stature physique and intellect.

The diabetic infant or child has to make good not only the wastage in its tissues but allowance must also be made for the fact that it has got to grow. Consequently more liberal diets are necessary than in the case of adults. This is specially true

PROTEIN, CARBOHYDRATE, AND FAT CONTENTS OF COMMON FOODSTUFFS

N B—The figures given apply to foods as served at table unless otherwise indicated

1 oz (=30 gm) contains—	Protein	Carbo- hydrate	Fat.	Calories (Approximate)
	<i>Gram</i>	<i>Gram</i>	<i>Gram</i>	
Vegetables (5 per cent group)	$\frac{1}{2}$	1	0	6
Vegetables (10 per cent group)	$\frac{1}{2}$	2	0	10
Potatoes	1	6	0	30
Oatmeal (dry weight, uncooked)	5	20	2	120
Bread	3	16	0	80
Animal Foods—				
Beef (roast average)	7	0	9	120
Bacon (fried)	5	0	15	155
Fish—				
Cod (boiled)	6	0	0	25
Herring (fresh cooked)	7	0	3	55
Dairy Products etc—				
Eggs (one average size)	6	0	6	75
Milk	1	1 $\frac{1}{2}$	1	20
Cream (average)	1	1	6	60
Cheese (Cheddar)	8	0	10	120
Butter or margarine	0	0	25	22 $\frac{1}{2}$

of the allowance of protein Under the age of 6 years, 3 to 4 gm of protein must be given per kilo of body weight, from 7 to 12 years, 2 to 3 gm per kilo, and between 12 and adult life, 2 gm

The total calories of the diet must be relatively far higher than in the case of adults, and range from 100 calories per kilo in early infancy to about 50 at age 12

Children are more liable to develop ketosis than are adults particularly when they develop any infection Consequently a relatively large carbohydrate ration should be allowed This should be about 100 gm at age 5, 130 gm at 10 and 160 gm or more at 15 With these amounts of carbohydrates there is little risk of ketosis

In diabetic children it is most important that infections such as the specific fevers tonsillitis, or even colds should be treated seriously Any kind of infection lowers the carbohydrate tolerance The patient should be kept in bed take plenty of fluids with an ample supply of carbohydrate, and if necessary take increased doses of insulin to control glycosuria If an infection is neglected the child is very liable to go into

coma, or at any rate to suffer a permanent decrease in carbohydrate tolerance.

Children are more prone than are adults to develop hypoglycæmic reactions, which are often induced by increased activity and physical exertion. The symptoms are often psychical and the child may be thought to be merely naughty or perverse. More severe reactions with convulsions have sometimes been mistaken for epilepsy.

Insulin is almost invariably necessary in diabetic children. In infancy it is best given at least three or perhaps four times daily, but when the child is of school age, if possible the number of injections should be reduced to two.

Diabetic Coma and its Treatment.—Before insulin, diabetic coma was the most frequent cause of death in youthful diabetics. Insulin has greatly reduced its frequency and diminished its dangers.

The symptoms of diabetic coma are due to the accumulation of aceto-acetic acid and possibly other ketone bodies in the blood. When coma is impending, ketone bodies are found in the urine, and the Gerhardt test is strongly positive. In addition, owing to the diminished alkali reserve, the CO_2 combining power of the blood is diminished to 20 volumes per cent. or less.

In diabetic coma the ketone bodies are excreted not only in the urine but through the lungs, and a smell of acetone can often be detected in the breath. Rarely the urine may contain no ketones, though acetone may be present in the breath. In such cases there is a failure on the part of the kidneys to excrete the ketone bodies, which is sometimes due to an associated nephritis.

Occasionally in diabetes of very acute type coma may be the first symptom, but in many cases the condition supervenes in diabetics who are the subject of an acute infection such as a local cellulitis, a general infection such as influenza, or even tonsillitis. In all infections, insulin, whether endogenous, i.e., secreted by the patient's own pancreas, or exogenous, acts less efficiently than normally. The omission of insulin or dietetic indiscretions in a severe diabetic may also precipitate coma.

At the onset of coma, constipation, abdominal pain and vomiting are common symptoms. The appetite fails and the amount of urine is often diminished owing to dehydration of the tissues. The pulse becomes thin and rapid, the blood pressure falls, and the intra-ocular tension is low. The patient becomes first confused and dazed, and if untreated, lapses into a coma from which he cannot be roused. The respirations are

deep and sighing and the term "air hunger" is often applied to the condition. Death usually occurs within a few days unless insulin is given.

Treatment of Diabetic Coma—This is quite as urgent a matter as that of an acute abdomen, but before starting active treatment with insulin it is essential that the diagnosis should be verified, especially when coma occurs in patients who are taking insulin. If hypoglycemia is mistaken for diabetic coma the results are likely to be disastrous. Fortunately there is seldom any real difficulty in the differential diagnosis of the two conditions. The important points are given below in tabular form.

	DIABETIC COMA	HYPOLYCEMIA
Type of onset	Gradual (several days)	Very sudden
Symptoms and signs	Indigestion nausea vomiting abdominal pain constipation Air hunger and deep respiration Rapid and thin pulse Ocular tension low Skin dry No convulsions Acetone in breath	Sensation of hunger Shallow respiration Normal pulse Ocular tension normal. Skin moist Tremor convulsions in late stages
Urine	Sugar * Ketones Albumen and casts common	Absent or trace Ketones absent No albumen or casts
Blood	Glucose usually above 3.0 mgm per 100 c.c. Urea often raised	Glucose usually below 60 mgm per 100 c.c. Urea normal.

* The presence of sugar in the urine does not necessarily preclude a diagnosis of hypoglycemia as the urine may have been secreted some hours previously and retained in the bladder.

The essential points in the treatment of coma are given below.

1 *Insulin*—This must be given at the earliest possible moment, either subcutaneously or intravenously. The latter route should be adopted in dangerously ill patients with failing circulation. The insulin in such a case should be given in a pint of saline to which glucose (see below) has been added. The dose will vary with the degree of coma. If the patient is completely unconscious, at least 100 units should be given during the first two hours of treatment. Four injections, each

of 25 units at half hourly intervals are probably more effective than a single dose of 100 units. Protamine zinc insulin should not be used owing to its slow rate of absorption.

2 *Glucose*—During the first few hours of treatment 5 grammes of glucose should be given for every unit of insulin injected. The object of giving glucose is to abolish ketoacidosis and to prevent unexpected hypoglycaemia. In comatose patients glucose is best administered by stomach tube after washing out the stomach. An Einhorn tube is readily swallowed even by a comatose patient if the bulb of the tube is pushed well to the back of the pharynx. It can be left in position for the later administration of fluids.

3 *Dehydration*—Patients in coma are always dehydrated. This is best combated in patients with circulatory failure by a saline or intravenous saline. In comatose patients at least 2 pints should be given early in treatment. Fluid may also be given direct into the stomach but it is important not to give more than about 5 oz each hour since large quantities may induce vomiting or even acute dilatation of the stomach.

4 *Alkali Treatment*—If the carbon dioxide combining power of the blood is less than 20 volumes per 100 c.c. sodium bicarbonate is advisable given either intravenously in 5 per cent solution or by stomach tube. The amount should be 10 to 20 gm. Excess may cause alkalosis.

5 *Constipation*—An enema should be given if the patient is not too collapsed, and a rectal saline drip started subsequently.

6 *Circulatory Failure*—The patient must be kept warm and nikethamide (Coramine) be given hypodermically. After recovery, he should be kept in bed for a week.

7 *Infection and Sepsis*—Coma is frequently induced by infection and sepsis. A careful physical examination should be made and if there is any collection of undrained pus this should be dealt with surgically at the earliest possible moment.

Patients in diabetic coma should be under continuous medical observation as the condition may change from hour to hour. Urine should be obtained by catheterisation if necessary every three hours and if the results of blood sugar estimations are readily available, these are helpful in deciding on the subsequent dosage of insulin. The total amount of insulin given during the first twenty-four hours of treatment varies from about 150 to 500 units. When in doubt it is safer to err on the side of too much rather than too little insulin. For several days after coma the diet should consist mainly of carbohydrate, fat should be reduced to a minimum.

Tuberculosis in Diabetics—While insulin does not appear to have appreciably decreased the incidence of tuberculosis among diabetics, it has certainly much improved what used to be a very grave prognosis. Unfortunately incipient phthisis is rarely diagnosed in diabetic patients as its early symptoms are often attributed to the diabetes. Deterioration in a diabetic should always arouse a suspicion of tuberculous infection and calls for thorough investigation.

A diabetic with phthisis should always take insulin and should be kept on a high caloric diet. The carbohydrate should be about 200 gm daily and an ample supply of milk is advisable as well as cod liver oil.

Pregnancy and Diabetes—Before the discovery of insulin pregnancy was rare except in very mild diabetics and in most severe cases amenorrhoea was constantly present. With effective insulin treatment pregnancy has become not uncommon.

Most pregnant diabetics show a definite loss of carbohydrate tolerance especially from the sixth month until delivery. This usually necessitates an increase in insulin which may be as much as 50 per cent. Foetal death is very common during the later months of pregnancy unless the mother's urine and blood sugar is kept within normal limits. Pregnancy produces an increased liability to ketosis and therefore a relatively high carbohydrate diet is required. The carbohydrate should be not less than 170 gm per diem and the protein allowance should be at least $1\frac{1}{2}$ gm per kilo of body weight. The blood sugar should not be allowed to exceed 0.16 per cent. Termination of pregnancy is now very rarely necessary.

It must be realised that the presence of a reducing substance in the urine of a pregnant woman does not necessarily indicate that she is suffering from diabetes. Osazones should always be prepared to exclude the possibility of lactose in the urine during the later stages of pregnancy. Also a blood sugar tolerance curve is called for in cases where the patient is not obviously diabetic. During pregnancy a low renal threshold for glucose is not at all uncommon and considerable amounts of sugar may be passed even though the blood sugar is within normal limits. Restriction of diet in such cases does nothing but harm. Glycosuria during pregnancy should be thoroughly investigated as a mild or potential diabetic may develop obvious symptoms for the first time during a pregnancy.

Operations on Diabetics—With the aid of insulin surgical operations on diabetics have become possible which in pre insulin days would have proved inevitably fatal. No diabetic however mild, should undergo an operation without

being put on insulin. If the operation is not an urgency, the patient should be stabilised on insulin and a diet containing about 200 gm of carbohydrate with a low fat content. For the twenty four hours immediately preceding operation he should take orange juice with glucose, oatmeal gruel and beef tea. Three hours before operation he should take orange juice with 50 gm of glucose which should be administered half an hour after 25 units of insulin.

If the operation is an urgent one it should not be delayed owing to the diabetes for more than a few hours. If the patient is already taking insulin his usual dose should be doubled and given at the earliest possible moment. If he is taking zinc protamine insulin this should be discontinued temporarily and soluble insulin substituted. Glucose should be given by mouth or rectum. A further specimen of urine should be obtained if possible after two hours and if this contains sugar and ketones further insulin should be injected. It is not necessary, indeed it is usually impossible to abolish glycosuria but the control of ketosis is most important. After operation glucose should be given in intravenous saline until fluids can be taken by mouth. If possible 100 gm of glucose should be taken daily for some days following operation. Insulin should be given in small but frequently repeated doses the actual amount to be determined on the results of frequent urine and blood sugar examinations.

Local or spinal anaesthesia should be employed if possible but if a general anaesthetic is necessary gas and oxygen is to be preferred. Ether is less satisfactory owing to liability to post operative vomiting and chloroform should never be used.

ACIDOSIS AND ALKALOSIS

Acidosis is said to be present when there is a diminution in the alkali reserve in the blood. It cannot be regarded as a disease in itself and it may arise under many varying conditions. In children there is often an acidosis in cyclic vomiting but there is no evidence that acidosis is the cause of the condition. Acidosis also occurs in starvation or severe and protracted vomiting. It also may be present in diabetes and nephritis.

Since acidosis is practically always associated with and dependent on some other pathological condition the symptoms present in a patient with acidosis are mainly dependent on the underlying disease. In severe acidosis the most characteristic feature is the deep respiration often termed air hunger.

This perhaps depends on the action of the acid on the respiratory centre. Acidosis is often accompanied by headache, nausea and vomiting.

Acidosis can be prevented by giving adequate amounts of carbohydrate and restricting the amount of fat in the diet. The administration of glucose and sodium bicarbonate will often relieve symptoms of acidosis.

Alkalosis implies an increase in the alkali reserve in the blood. It is an uncommon condition but sometimes arises from the ingestion of large amounts of alkali, such as may occur in the intensive alkaline treatment of peptic ulcer or of nephritis. When there is severe vomiting in pyloric stenosis alkalosis may follow the loss of acid in the vomit. When alkalosis is considerable the blood urea may be much elevated and the patient may also show signs of tetany.

The chief symptoms of alkalosis are headache, nausea, vomiting, anorexia, and drowsiness. If the condition is due to the taking of alkaline medicines these must be discontinued at once and plenty of fluids given by mouth or rectum. If it is due to pyloric stenosis, operation is required (*vide p. 406*).

GOUT

Gout is a disease characterised by the deposition of sodium urate in the joints, an increase in the amount of uric acid in the blood, and a tendency to the development of nephritis.

Ætiology—Referring to gout, Sydenham, himself a sufferer from the disease, wrote "More wise men than fools are victims of the affection." Although at the present time gout is considerably less common than it was a century ago, the disease is certainly more common in private than in hospital practice.

Many factors such as climate, heredity and over-indulgence in food and drink have been regarded as of importance in the ætiology of gout. Of these, perhaps the most important is heredity. Probably 50 per cent. of the cases have a gouty family history. Males are far more commonly affected than females, in fact, gout in women is comparatively rare. Alcohol has always been regarded as a most important factor in the production of the disease but it would appear that fermented liquors, such as beer and wines, are more deleterious than are distilled spirits such as whisky or gin. Perhaps an even more important predisposing factor than alcohol is persistent overeating. In all probability the frequent occurrence of gout among the English upper classes in the eighteenth

century was due to the large meals and liberal indulgence in port which were so characteristic of that period

Gout is uncommon before forty, and such cases as occur at an earlier age are nearly always inherited

Gout and chronic lead poisoning are sometimes associated. It is usually maintained that lead poisoning is a predisposing factor for the production of gout, but it may equally well be held that gout renders its victims more liable to lead poisoning should their work bring them in contact with lead

Pathology—Although the most striking symptom in gout is an arthritis associated with the deposition of sodium biurate in the cartilages of the joints, the disease is more than an arthritis and must be classified under the heading of metabolic disorders in view of the disturbance in the metabolism of uric acid and the purin bodies which is always present

All cell nuclei contain a substance, nucleic acid which is combined with protein. It is from this that the uric acid of the urine is derived. Normally about 1 gm. of uric acid is excreted daily in the urine, and this is derived from two sources—the nucleic acid molecule in the food and that derived from the breakdown of cell nuclei in the body. The former is known as the *exogenous* and the latter as the *endogenous* uric acid. On a purin free diet endogenous uric acid is alone excreted, but the amount varies in each individual, ranging from 0.5 to 0.7 gm. a day. When purin containing food such as liver, kidney or pancreas, is eaten, only about 25 to 50 per cent. of the purin appears in the urine as uric acid, the balance is probably destroyed in the blood.

Normally the blood contains about 2 to 3.5 mgm. of uric acid per 100 c.c. which circulates in the form of sodium biurate. In patients with gout there is an increased percentage of uric acid in the blood and even when foods containing purin are avoided the blood uric acid amounts to between 4 and 7 mgm. per 100 c.c. or approximately two to three times that in normal blood. The output of endogenous uric acid in gouty patients is usually low. For a few days before an attack of gout the uric acid excretion falls but after the development of symptoms a rise in the excretion takes place with a diminution in the uric acid in the blood. From these facts it would appear that in gout there is a retention of uric acid by the kidneys, but whether the symptoms of gout are solely due to such a retention is more doubtful as it has been clearly proved that in nephritis there is often a considerably greater excess of uric acid in the blood than is the case in gout, though in such cases of uric acid retention no symptoms of gout occur.

Morbid Anatomy.—Gout in itself is not a fatal disease, but death often takes place as a result of associated conditions such as arteriosclerosis with cerebral hæmorrhage, or chronic nephritis with uræmia. A gouty joint examined at autopsy shows, in the cartilage, patches and streaks of a white chalky material, which, on analysis, is found to consist of sodium biurate, this substance is also found in the periarticular tissues such as ligaments, tendons, and synovial membranes, in severe and chronic cases the deposition of sodium biurate may infiltrate the skin, which eventually ulcerates, leaving the chalky material exposed, the ends of the bones in the neighbourhood of joints affected by chronic gout show areas of absorption, translucent in an X ray plate, where the bony tissue has been replaced by sodium biurate. The joints most commonly affected are the metatarso phalangeal joints of the big toes, the joints of the fingers, the ankles, knees, and wrists. In addition to the deposits of sodium biurate in the joints, a similar condition is found in the cartilage of the ear, these deposits are very small and are known as *tophi*.

Symptoms — Acute Gout — The clinical picture of an attack of acute gout is so characteristic that the disease in this stage is seldom misdiagnosed. The patient as a rule has been in good health, and is awakened during the night by acute pain in one of the big toes. The pain is excruciating, and there is a burning sensation, as if a hot iron was being pushed into the toe joint, pressure or movement aggravate the pain. With the approach of morning the symptoms abate somewhat, but the joint is red and glazed in appearance, slightly swollen and very tender. The temperature is usually between 101° and 103° F, and there is loss of appetite and general malaise. The paroxysms of pain recur on successive nights and the joint becomes more markedly swollen, the surrounding skin is oedematous, and the disease may involve the big toe on the other foot, or less commonly other joints. In about a week the symptoms disappear and the patient often feels remarkably fit. Recurrences of acute gout follow the first attack, usually within a year, and in the absence of treatment and attention to diet and régime may become increasingly frequent. During an acute attack there is a leucocytosis, often up to 20 000, with a relative increase in the polymorphonuclear cells.

Chronic Gout — After a number of repeated attacks of acute gout a condition arises in which there is never complete relief from symptoms. The joints especially those of the big toes, of the tarsus, and of the fingers, are much deformed, tophi appear in the cartilages of the ears or around the joints, and

there is often swelling of the olecranon and prepatellar bursa. Suppuration never occurs, although the chalky material may ulcerate through to the surface.

The sufferer from gout, whether in the acute or chronic stage, is notoriously irritable, but yet retains his intellectual powers unimpaired. On physical examination the heart is often found to be enlarged to the left, and the blood pressure is raised. Traces of albumen are common, and if renal function tests are carried out they often reveal a diminished excretory power in the kidneys.

Many other symptoms occurring in patients, with or without obvious gout, have been ascribed to "suppressed gout" or a "gouty diathesis." Among these are eczema, brittle nails, conjunctivitis, and iritis.

Diagnosis.—The association of acute arthritis in the big toe joint, with a marked increase in the severity of symptoms during the night, is pathognomonic of acute gout. More difficult of diagnosis are the cases of chronic gout with deformity of the joints. It is in such patients that the discovery of tophi may give the clue to a correct diagnosis. If the blood is found to contain more than 4 mgm of uric acid per 100 cc this supports a diagnosis of gout. Recovery of function in gouty joints is much more rapid than it is in cases of infective arthritis.

Treatment.—Patients with a family history of gout should be specially abstemious as regards both food and drink. By reasonable physical activity and dietetic restriction they should endeavour to keep themselves well below average weight.

When symptoms of gout have become manifest, restriction of diet, both qualitative and quantitative, is necessary. The great majority of patients are over forty and probably have been in the habit of eating too much. The articles of food which contain most purins are sweetbreads, kidneys, and liver, and these are naturally forbidden. Meat may be allowed in strict moderation but the diet should mainly consist of vegetables, bread, fresh fruit, and cheese. All fermented wines and beer are forbidden, and painful experience usually teaches the sufferer to avoid them. A small amount of spirits does not appear to be harmful.

During acute attacks the affected limb must be covered with cotton wool and the pressure of the bedclothes avoided by the use of a cradle. Hot fomentations or lead and opium lotion may be applied locally. Colchicum is almost specific in relieving the pain. It should be given with salicylate and an alkali (tinct colchicum 15, sod sal gr 20, pot bicarb gr 30, extract glycyrrhizæ liq m 10, aqua menth pip ad 3i, four-

hourly) Colchicum irritates the gastro intestinal tract and should not be taken for more than three to four days. The bowels should be opened with 1 gr of calomel followed by a saline purgative. When symptoms have subsided, the patient may be put on cinchophen (atophan) in 15 gr doses thrice daily, given for two days every week for four weeks. Atophan increases the excretion of uric acid and diminishes its percentage in the blood. It should only be given when hepatic efficiency tests are normal, as its unrestricted use may lead to dangerous toxic jaundice.

Spa treatment has long been popular in the treatment of gout. It is doubtful whether the various waters have any specific action on the disease, though, undoubtedly, the regulated life and diet are beneficial.

OBESITY

The disadvantages, or rather the dangers, of obesity have only been fully realised within comparatively recent years. Even at the present time overweight is still only too often regarded by the layman as an indication of robust health.

Needless to say, there is no satisfactory formula for ascertaining the ideal weight in relation to age, sex, and height. The experience of life assurance companies is embodied in the table given in the Appendix on Life Assurance Examination (*vide p 1124*). Though the figures in the table give an indication of the average weights a person even 20 per cent above the tabular weight is not necessarily unduly obese.

The best criterion of obesity is not so much the patient's weight as his or her appearance. The general build, and in particular the abdominal girth in relation to the chest measurement, are perhaps the most reliable guides. When the abdominal measurement exceeds that of the unexpanded chest, the individual may always be regarded as too fat.

No one likes to be accused of obesity, and it is rare to meet any person, however fat, who will admit to overeating as a causative factor. The patient prefers to ascribe the condition to familial predisposition, while the physician often postulates somewhat hypothetical disorders of the endocrines. Though undoubtedly pathological obesity may occur as the result of endocrine upset, it is probably true to say that overeating and a sedentary life account for the majority of cases. Heredity is also a potent factor.

It is often stated that alcohol produces obesity. To a certain extent this is true, at any rate, as regards the chronic

beer drinker Too often, however, the total abstainer and non smoker in compensation for his self denial is apt to consume a diet quite out of proportion to his needs, which often includes an excessive amount of sweets and chocolate

Exercise is more effective in the prophylaxis than in the cure of obesity, for, unfortunately, once the condition is well established a vicious circle is set up, as the physical disabilities induced by obesity forbid adequate exercise

Dangers of Obesity—The statistics of life assurance companies prove quite conclusively that the unduly obese are bad lives The special dangers are classified below —

1 *Acute Illnesses*—Any surgical procedure, especially an abdominal operation, is notoriously more difficult and dangerous in the obese than in the spare individual Moreover, the prognosis in acute infections, such as pneumonia, is distinctly unfavourable in the obese

2 *Diabetes*—This disease is very frequently associated with obesity

3 Cholecystitis and gall stones are more common in obese than in spare persons

4 Osteo arthritis, particularly in the lower extremities

5 Varicose veins are frequently troublesome

6 *Chronic Diseases*—In obesity there is a tendency to fatty infiltration of the heart muscle Chronic bronchitis, arteriosclerosis, and angina are often associated conditions

Obesity in Endocrine Disorders—The thyroid and pituitary glands are known to influence fat metabolism Hypothyroidism or myxoedema is always associated with some degree of obesity, as are certain anomalies of pituitary secretion, such as Frohlich's and Cushing's syndromes At the menopause there is often a tendency for the weight to increase rather rapidly, perhaps as a result of ovarian hypofunction Similarly castration results in adiposity, which is also common in the adreno genital syndrome (*vide p 281*)

Treatment—In obesity, not obviously related to disorders of the endocrine glands much can be done by readjustment of the general regime, especially as regards diet The constituent of food which is mainly responsible for the production of obesity is carbohydrate, and this, therefore, needs to be restricted in anti-obesity diets The factor limiting this restriction is the palatability of the diet, and it is usually necessary to give up to 120 grm *per diem* As it is desirable that the patient should consume his own fat, the intake of fats must be severely restricted It is usually impossible to cut down this to below 40 to 50 grm *per diem* Proteins

may be taken in normal amounts as they are not productive of obesity in themselves and also have a tendency to increase metabolism

The following diet has been proved effective in the Dietetic Clinic at the Royal Infirmary, Edinburgh, and is not unpalatable —

Approximately CHO = 116, Prot = 70, Fat = 52, Calories = 1,200

Breakfast—

Tea or coffee with milk from ration

1 orange or half grape fruit

1 oz brown bread (one thin slice), or 2 Ryvita or Vitaweat biscuits

1 egg or 1 oz (one thin slice) of lean ham or tongue

Butter from ration

Dinner—

Bovril, Oxo, or clear soup *ad lib* if desired

An average helping (2½ oz) of any lean meat (except pork), fish (not fried), poultry or game (except geese or duck) or rabbit

Large helping of any vegetable, except potatoes peas, beans, or lentils

Fresh fruit salad when possible (no oil or cream in dressing)

Fruit, 4 oz of 10 per cent group (*vide p 310*)

½ oz (one section) cheese

2 water biscuits or ½ oz (half thin slice) brown bread

No sweet wine, beer, stout, spirits, or aerated waters

Tea—

Tea with milk from ration

1½ oz brown bread (one and a half thin slices) made into a sandwich with tomato, lettuce, or cress

Supper—

Bovril, Oxo or clear soup *ad lib* if desired

Average helping (2½ oz) lean meat, fish, etc., as at dinner

Vegetable and fruit as at dinner

½ oz brown bread (half thin slice) or 1 Ryvita biscuit

Daily—

Butter, ½ oz

Milk, ½ pint

No sugar to be used—saccharine can be substituted if desired

Drink plenty of water in between meals

The following articles should be completely forbidden all forms of sugar, chocolates, jam, and the like, potatoes, green peas, all starchy foods such as rice or macaroni. The fat-containing fish, such as sardines and salmon, are better avoided. The intake of salt should be limited to that used in cooking. Consumption of beer, stout, and sweet wines, such as port, must be stopped, but spirits in small quantities or light wines, such as claret, probably do no harm. Fluids can be taken in normal amounts but are best drunk between rather than with meals

In conjunction with dietetic restrictions on the above lines an attempt must be made to encourage physical exercise, which need not, however, be violent. If the patient is both elderly and obese, undue exercise is likely to be not only ineffective but dangerous.

The value of drugs in obesity is doubtful, except where there is definite evidence of endocrine disorder. Many proprietary remedies contain thyroid and if used indiscriminately may be dangerous. No patient should be allowed to take thyroid except under close medical supervision. It must be remembered that the action of thyroid is to some extent cumulative. The citrates are often prescribed but there is little evidence that they have any effect. Dinitrophenol preparations are definitely dangerous and should never be given.

In obesity following the menopause, thyroid extract is often effective not only in controlling the weight but in the alleviation of the manifold symptoms so often present at that period. The dose may need to be gradually increased up to 5 gr a day or more. Thyroid is also extremely valuable in myxedema. Pituitary extract is, however, probably completely ineffective in obesity due to disorders of that gland.

Unfortunately, it is easier to give instructions as to diet than to see that they are carried out. Rigid adherence to a diet which will produce steady loss of weight needs, as a rule, more determination and self control than the average subject of obesity can muster. Hence the value of spa treatment with its strict dietetic control and routine exercise. Under a satisfactory dietetic régime about 2 to 3 lbs should be lost weekly. Too rapid a loss may produce lassitude and exhaustion.

Adiposis Dolorosa (Dercum's disease)—This condition occurs chiefly in middle aged females, who become enormously obese, and develop diffuse and often symmetrical masses of fat on the trunk and limbs, which are extremely tender on pressure. In addition the patient is usually depressed and emotional, and the obesity leads to asthenia. Although adiposis dolorosa has been attributed to pituitary dysfunction there is no evidence in support of this view. Treatment is unsatisfactory but dieting and thyroid extract may be tried.

VITAMIN DEFICIENCY DISEASES

In addition to an otherwise adequate diet certain accessory food factors called vitamins, are necessary for growth and health. Several vitamins can now be synthesised and the existence of many others has been proved. Deficiency of these

substances produces certain diseases which may be prevented or cured by giving the appropriate vitamins

All the vitamins are either water soluble or fat soluble. As all the members of the water soluble group occur in similar foodstuffs a diet deficient in one is almost certain to be deficient in the other members of the group, the same applies to the fat-soluble group

The first effect of deficiency of any of the vitamins is the onset of various subjective symptoms such as lassitude, depression, irritability, weakness, anorexia, insomnia, and an increased susceptibility to infections. The onset of objective signs indicates a very marked degree of deficiency

Two important deficiency diseases—rickets and infantile scurvy—are described in the section dealing with diseases of infants (*vide pp 232, 229*)

Vitamin A (fat soluble)—This is present in butter, eggs and all animal fats. It is also derived from carotene, a red pigment found in certain vegetables, and converted into vitamin A in the body

The early manifestations of vitamin A deficiency are the development of night blindness, and a condition of the skin known as follicular hyperkeratosis, in which the skin resembles marked "gooseflesh". Gross deficiency of this vitamin produces xerophthalmia. Recently it has been suggested that Darier's disease and pityriasis rubra pilaris are associated with deficiency of vitamin A. In children lack of vitamin A results in imperfect formation of the enamel of the teeth

Vitamin D (fat soluble)—Like vitamin A this vitamin is present in animal fats. Deficiency in children gives rise to rickets (*vide p 232*). There is little known about the role of vitamin D in adults

Vitamin E (fat soluble)—This vitamin is present in vegetable oils, especially in wheat germ oil. In animals, deficiency gives rise to abortion and to the development of a characteristic neuromuscular disease. The treatment with vitamin E of recurrent abortion, the muscular dystrophies, and motor neurone disease, in humans has been disappointing, and there is no conclusive evidence that it has any beneficial effect on any of these conditions

Vitamin K—This fat soluble vitamin is present in kale, spinach and other vegetables. It is essential for the formation of prothrombin and is of great value in the prophylaxis of hæmorrhage which may occur in patients with obstructive jaundice. It is doubtful whether avitaminosis K occurs merely as a result of a deficient diet. Absence of bile salts prevents its

absorption and extensive disease in the liver may interfere with the formation of prothrombin. The chief practical use of vitamin K or synthesised products having a similar action is its pre operative administration in jaundiced patients. It may also be of value in hæmorrhage of the new born.

Vitamin B Complex (water soluble)—The chief sources of vitamin B complex are whole wheat (not white flour), yeast vegetables, and dairy products.

The vitamin B complex includes vitamins B₁, B₂, B₄, B₅ and the vitamin B₆ complex which includes riboflavin, nicotinic acid, pantothenic acid, the filtrate factor, and vitamin B₆. Several other members of the B complex are known to exist, but have not yet been definitely identified. Only vitamin B₁, riboflavin and nicotinic acid will be considered here.

Vitamin B₁ (Aneurin)—This vitamin is fairly heat stable. It is intimately concerned with carbohydrate metabolism and in its absence pyruvic acid and lactic acid accumulate in the tissues.

The early signs of deficiency of this vitamin are palpitations, tachycardia, loss of vibration sense in the legs, tenderness of the calf muscles, and the loss of reflexes. Gross deficiency produces beri beri.

Riboflavin—Several conditions result from deficiency of this vitamin. The lips develop a deep vermilion colour with a thin shiny, and denuded mucosa, a condition known as cheilosis. Painful ulcerations occur at the angles of the mouth (angular stomatitis) and these may have a superimposed monilia infection when the condition is called perleche. The tongue is clean lint sore, and is usually purplish red with enlarged flattened papillæ.

Eye lesions are sometimes the earliest signs and consist mainly of corneal vascularisation with photophobia and itching and burning of the eyes.

Nicotinic Acid—The earliest lesions in cases of deficiency of this vitamin are a glossitis in which the tongue is sore, clean fiery red, and shiny, and a dermatitis on exposed parts of the body. The later lesions are described under pellagra.

Recently it has been suggested that infections with the organisms associated with Vincent's angina are connected with a nicotinic acid deficiency, but the evidence in support of this is at present by no means conclusive.

BERI BERI AND PELLAORA

In the past there have been many theories about the ætiology of these two diseases, but it is now recognised that both are

essentially due to vitamin deficiencies, although certain other factors may be contributory causes. In recent years beri beri has been said to be due to vitamin B₁ deficiency and pellagra due to nicotinic acid deficiency. It is now considered that both these diseases are due to a multiple B complex deficiency, beri beri being produced when the deficiency of vitamin B₁ is dominant, and pellagra when nicotinic acid is mainly deficient. This theory is supported by the fact that a deficiency of only one member of the B complex is extremely unlikely and that beri beri and pellagra show great variety in their symptomatology, many of the symptoms being common to both diseases, probably riboflavin deficiency plays an important role in both. In fact, it is best not to look upon beri beri and pellagra as two definite diseases, but rather as convenient labels for the two extremes of all the symptom complexes found in vitamin B complex deficiency.

BERI BERI

Morbid Anatomy—The post mortem findings are those associated with cardiac incompetence and peripheral neuritis, the nerves of the legs being particularly affected.

Symptoms—Either the cardiac or neuritic lesions may predominate, giving rise to "wet" or "dry" beri beri, respectively.

The onset of beri beri is insidious, early symptoms are weakness or a feeling of weight in the legs, palpitation, and dyspnoea. The knee jerks are diminished and ultimately completely lost, symptoms referable to sensory nerves also occur in the form of paresthesiae, patches of cutaneous anaesthesia, and tenderness of the calves. The weakness of the legs gradually increases, and there is obvious muscular wasting, unless this is obscured by oedema. The muscles show the reaction of degeneration.

The heart is always enlarged, and there is often a marked engorgement of the veins. Occasionally cardiac failure occurs early and results in sudden death.

Diagnosis—The combination of peripheral neuritis with oedema presents a picture seen in no other disease. It is important, however, to avoid overlooking cases where the main symptoms are neuritic. Tenderness of the calves, diminution of the knee jerks, and areas of paresthesia or anaesthesia should arouse suspicion of beri beri when they occur among persons whose diet is open to suspicion.

Treatment—As in all diseases prevention is better than cure and the provision of food containing the vitamin B complex is a sure protection against beri beri. The most satisfactory method of supplying the deficiency, in armies or on board ship where fresh food is difficult to obtain is to substitute whole meal for white bread. If rice forms the staple article of diet as it does in many eastern countries, it should be undermilled in order that part of the vitamin containing husk may be retained.

When there is evidence of cardiac involvement the patient must be strictly confined to bed and careful nursing is essential. When oedema is marked saline purgatives should be given. A good mixed diet with plenty of milk, fresh meat and vegetables must be ordered and in addition yeast and whole wheat should be added to the diet to supplement its vitamin content. Several proprietary preparations of vitamin B₁ (aneurin) are available and can be given either by mouth or by injection but it must be remembered that this is not the only vitamin which is deficient.

PELLAGRA

Pellagra is a chronic disease characterised by gastro intestinal and nervous symptoms and an erythematous rash.

Symptoms—The most characteristic though not necessarily the earliest manifestation of the disease is an erythematous rash of somewhat peculiar type and distribution. In its early stage it resembles an erythema such as may be produced by sunburn or a mustard plaster. Later the skin becomes thickened and resembles parchment and there is often pigmentation with desquamation of the epithelium. The rash is most commonly seen on the parts of the body exposed to sunlight particularly the back of the hands and around the wrists and neck. The extensor rather than the flexor surfaces are affected. The skin condition starts most commonly during the spring and tends to disappear after a few months only to recur during the following spring.

The gastro intestinal tract is often affected. Vague digestive disturbances such as flatulence and eructations are common. The tongue is red and desquamated and the patient frequently complains of a burning sensation in the mouth, there is persistent diarrhoea in the later stages.

The most serious feature of the disease is the involvement of the central nervous system which tends to occur in the more chronic and severe cases many of whom ultimately end their

days in an asylum. Subjective symptoms such as depression, insomnia and headache are common, and not infrequently these progress to a definite dementia with hallucinations and delusions, which may necessitate certification. In the spinal cord, pathological findings, similar to those of subacute combined degeneration, occur with spastic or flaccid paralysis, and increase or loss of the tendon reflexes.

Diagnosis—This rests mainly on recognition of the rash, which in most cases is typical. Sprue is distinguished by the characteristic bulky and fatty stools.

Treatment—A good mixed diet with the addition of yeast, and with plenty of fresh fruit and green vegetables will frequently effect a cure by itself.

Administration of nicotinic acid in 50 mgm. or larger doses after meals, a daily dosage up to 500 mgm. being given, is usually rapidly effective. But the cure will not be permanent, even if the nicotinic acid is continued, unless the general deficiency of the vitamin B complex is given adequate attention.

SCURVY

Vitamin C (Ascorbic Acid)—This substance is water soluble, and is rapidly destroyed by heat when in alkaline solution. It is present in all fresh fruits and vegetables, especially lemons, oranges and tomatoes. Although potatoes are not very rich in vitamin C, they supply a very large part of the daily requirement wherever they form a staple food owing to the large quantity consumed. In recent years good results have been claimed for the treatment of many diverse conditions with ascorbic acid, but little conclusive evidence has been produced to support most of these claims. Gross deficiency of vitamin C results in scurvy and deficient wound healing, but all the evidence tends to show that a patient has to be almost scorbutic before any lack of wound healing is revealed.

Scurvy has been one of the great scourges of armies in the field, and it was the dread of seamen on long voyages until the preventive qualities of lemons were discovered. At the present time the disease is rare in adults, but it is still relatively common in infants in whom it produces a rather different clinical picture, which is described as infantile scurvy, or Barlow's disease (*vide p. 229*).

Pathology—The most marked feature of the disease is a tendency to hemorrhage, so that extravasation of blood and

petechial hæmorrhages may be found in any part of the body. This hæmorrhagic tendency is associated with a loss of and an inability to re form intercellular matrix.

Symptoms—The onset of scurvy is usually insidious with pallor lassitude and dyspnoea as early symptoms. If the dietetic deficiency is not corrected more characteristic symptoms develop. The most striking of these is the condition of the gums which become congested and spongy, and bleed readily. As the disease progresses the swollen gums may almost completely envelop the teeth which become loose and may ultimately fall out. It should be noted that the gums of edentulous scorbutic patients usually remain normal. At the same time petechial spots appear on the skin particularly on the legs together with larger ecchymoses. Sometimes hæmorrhage takes place in the substance of a muscle producing a hard brawny swelling tender to the touch. Other manifestations of the hæmorrhagic tendency are sub periosteal hæmorrhages epistaxis hæmaturia and sometimes cerebral hæmorrhage. Uncomplicated scurvy is apyrexial but sufferers from it are very liable to intercurrent infections and frequently die of pneumonia. In the later stages there are œdema of the legs and sometimes effusions in the pleura and pericardium.

Diagnosis—In the presence of many cases diagnosis is easy but with sporadic cases there may be confusion with purpura hæmorrhagica. In cases of doubt a blood platelet count may be helpful as in scurvy the count is high while in purpura it is often very low. The therapeutic test is also a valuable aid in diagnosis for a patient with scurvy when put on a diet rich in vitamin C shows a rapid improvement.

Prophylaxis and Treatment—Where there is no poverty and a mixed diet is eaten there is little risk of scurvy among adults. Where it is impossible to get suitable food a ration of lemon juice is an effective prophylactic. Scurvy sometimes occurs in patients on a restricted diet such as those on strict dietary treatment for peptic ulcer.

The symptoms disappear with marvellous rapidity when the patient is put on a diet with an ample surplus of fresh fruit particularly oranges and lemons fresh milk cabbage salads tomatoes and potatoes. The vitamin is destroyed by alkalis and the use of soda in cooking green vegetables must be forbidden. Scurvy can be rapidly got under control by giving ascorbic acid either by mouth (150 to 300 mgm daily) or by injections in amounts up to 500 mgm in urgent cases. Some cases have however been reported which did not respond to the synthetic ascorbic acid but recovered rapidly on orange

juice. It is important always to attend to the diet, as probably all cases are deficient in other vitamins as well.

Patients with scurvy should be kept in bed until marked improvement has taken place, in view of the risk of sudden syncope and heart failure, even on slight exertion. For pain or restlessness morphia may be necessary.

J. J. CONYBEARE.

W P. STAMM

DISEASES OF THE BLOOD, SPLEEN, AND LYMPHATIC GLANDS

DISEASES OF THE BLOOD

PHYSIOLOGY

TO understand many of the features presented by the diseases discussed in this section it is essential to remember certain physiological points concerning the circulating blood, and the mechanism by which departures from the normal may occur.

When interpreting blood counts, not only must we appreciate what may be called "normal variations," but also remember the most acceptable theories concerning the origin of the various cells in the blood. The red cells consist of a stroma or framework, composed chiefly of protein material, containing in its meshes hæmoglobin. The cells are soft, flexible, and elastic, and can thus squeeze through apertures and channels narrower than themselves. They are non-nucleated, biconcave discs of about 7.4μ average diameter, form about 50 per cent of the total mass of the blood, and total in men about 5,000,000 per cubic millimetre or slightly more, and in women about 4,500,000. The total surface area of the corpuscles is about 3,000 square metres or 1,500 times the surface of the body itself—a point of some importance in facilitating oxygen interchange. In the adult the red cells are derived from the red bone marrow, in which tissue all the precursors of red cells are found. As will be seen later, the red cells, as seen in a blood film, may show abnormalities of the following types:

(a) Shortage of iron intake or excessive loss (hæmorrhage) may cause the cells to be poorly filled with hæmoglobin, and appear pale and somewhat irregular in shape. These pale cells have a low colour index, i.e., the amount of hæmoglobin per cell is below normal, the normal cell having an index of unity.

(b) A sudden call for large numbers of new cells, as after a large hæmorrhage, may result in the turning into the circulation

of many polychromatic or young cells (reticulocytes), or cells with small round nuclei (normoblasts), which would otherwise have had time to develop normally before being sent out (c) Some pathological process directly affecting the bone marrow (as in pernicious anæmia, leukaemia, etc.) may prevent the proper maturation of the reds, which therefore appear in the circulation in their quite immature forms (megaloblasts, erythroblasts, etc.) (d) Some toxic substance may be actually taken up by the red cell and produce a characteristic microscopical appearance, *eg.* the punctate basophilia of lead-poisoning

Two types of white cell are easily distinguished, namely, the granulocytes containing granules in their cytoplasm (neutrophil polymorphs, eosinophils, and basophils) and those without granules (lymphocytes). In the main, granulocytes are formed only in the bone marrow, and lymphocytes only in lymphatic tissue. Both these tissues form part of the reticulo-endothelial system of cells, and it is clear that any disturbance of this cell system, such as that which occurs in leukaemia, is especially liable to be accompanied by marked disturbance in the patient's white count. On the other hand, the more common departures of the white count from normal are in the nature of physiological responses of the tissues to abnormal stimuli. For example, the granulocytes which are mainly phagocytes show increased production in septic states, such as pneumonia, where cellular debris has to be removed from the tissues. Again, the increase in lymphocytes in tuberculous infection is simply an indication of the glandular hyperactivity which is part of the natural defensive reaction. As in the case of the red cells, immature white cells may appear in the blood if there is a very sudden and vigorous call for any particular type. This is specially well seen in the case of the granulocytes (polymorphs), where a satisfactory defensive response results in the appearance of many "young" forms in the circulating blood. As the younger the cell the fewer the lobes seen in its nucleus, the nature of the response can be recorded as the Arneeth count, which is a percentage record of the number of cells having one to five lobes to their nuclei. Normally, the greatest number have two, three, or four lobes. In a vigorous defensive leucocytosis the majority may have only two, while many young forms with only a horse shoe shaped, unlobed nucleus will occur. This change in predominance is described, according to the customary method of recording (Arneeth count), as the "shift to the left." In the case of deficient white cell production, such as occurs in pernicious and

aplastic anæmias, the predominant cell may be older and therefore possess more nuclear lobes, in which case the count shows a "shift to the right"

The frankly immature cells, namely, myeloblasts and myelocytes, appear with any frequency in the circulating blood only when there is gross disturbance, general or local of some part of the blood forming system. Their appearance represents failure in function and in proper maturation, and never occurs as a physiological response to external stimuli.

One other cellular element in the blood remains to be considered, namely, the platelets. Probably they also arise from the bone marrow during the development and differentiation of the megakaryocytes. It is, however, clear that they are intimately concerned with coagulation. Their function appears to be, however, concerned not with the production of the fibrin clot as such, but with its proper contraction and firmness after the fibrin has been deposited. Without a full quota of platelets, coagulation of the blood is not efficient in closing breaches, traumatic or toxic, in the capillary walls. Normally the blood contains about 250,000 platelets per cubic millimetre. Great increases above this level, such as may occur in puerperal states, are found to cause a liability to thrombosis, whereas falls to about 40,000 per cubic millimetre result in a liability to purpura and extensive bruising from quite trivial trauma. At about 15,000 per cubic millimetre there is usually a tendency to spontaneous hæmorrhage from mucous membranes.

In this connection determination of the *bleeding time* and *clotting time* may be of the greatest importance. The bleeding time is that taken for oozing to cease from a sharp single finger-prick made with a Hagedorn cutting needle. The drops of blood are blotted off the finger at one quarter minute intervals without touching the skin. According to the depth of the prick, bleeding will cease in a normal person in three to four minutes. Variations depend upon the rate of clot retraction as well as upon actual coagulation. Thus when there is a platelet shortage, formation and fixation of an efficient clot is delayed, and therefore the bleeding time is prolonged, although the rate at which the first actual coagulum forms may be normal. To determine the clotting time the most satisfactory method is that of Landlaw. By this method the normal clotting time is three to four minutes.

A physical property of drawn blood, observations of which may be helpful clinically, is the *sedimentation rate* of the red cells. When a column of freshly collected, citrated blood is set up, the rate at which the red cells sink down to form a

compact layer depends upon variations in the plasma proteins, which are in turn related to the presence or absence of tissue breakdown proceeding in the body. The more active the tissue change, the greater the rate of fall of the red cells, and the test becomes a delicate indirect method of detecting the activity or quiescence of inflammatory processes not readily observable by direct means. The normal blood sedimentation rate is 1 to 8 mm. in one hour.

The subject of blood groups is discussed later in connection with blood transfusion.

The specific gravity of blood is normally about 1.059. In anaemia this figure may be much lower, for example, a haemoglobin of 30 per cent. is usually associated with a specific gravity of about 1.035. In collapse, or conditions in which great loss of fluid occurs, *e.g.* cholera, a marked rise may be noted.

Normal red cells can resist the osmotic pressure set up when they are immersed in saline of 0.45 per cent., isotonic saline being 0.9 per cent. and are not laked until they are immersed in weaker saline solutions. The highest dilution which any particular cells can resist is taken as a measure of their fragility, a determination of great diagnostic value in acholuric jaundice, in which condition the cells are unusually fragile and therefore tend to haemolyse while in circulation, thus producing jaundice.

The average quantity of haemoglobin in the blood of healthy adult males is about 16.2 mg. per 100 c.c. The average red cell count in the normal male is actually nearer to 5,500,000 than 5,000,000 per cubic millimetre, and the higher figure must for normal red cells, therefore correspond to about 16.2 mg. of haemoglobin per 100 c.c. If we take, as is usual, only 5,000,000 per cubic millimetre as the 'normal' then for purposes of estimating the colour index (*vide p.* 351), which is Haemoglobin percentage, and represents the relative amount of

Red cell percentage
 haemoglobin per cell the 'normal' or 100 per cent haemoglobin figure as marked on the haemoglobinometer scale should correspond to only about 14.5 mg. of haemoglobin per 100 c.c. Unfortunately the absolute haemoglobin value to which the 100 per cent mark corresponds varies with the type of instrument. In the older Haldane carboxyhaemoglobin haemoglobinometer it is only 13.8 mg. in the more recent Sahli and Hellge acid haematin types it is about 14.7 mg. With the object of fixing a universal standard an official committee is now sitting. Meanwhile in making clinical haemoglobin estimations it seems

advisable to use an apparatus (one of the acid hæmatin types) in which the normal 100 per cent reading is given when patient's blood contains 14.5 to 14.7 mg per 100 c.c. Then if the "normal" red count is taken to be 5,000,000 per cubic millimetre, the figure for the colour index will be truly representative, as it is meant to be, of the relative amount of hæmoglobin per cell, 1.0 being the normal index. To determine the hæmoglobin content of the blood with chemical accuracy, the best methods are based either upon estimation of the oxygen-carrying capacity or the iron percentage of the fresh blood.

BLOOD TRANSFUSION

Although the idea of blood transfusion originated many centuries ago, it is only during the last twenty years that transfusion of blood from one individual to another has become a relatively safe and simple procedure. This result is due to two discoveries: firstly, a knowledge of the blood groups in human blood; secondly, the use of sodium citrate as an anti-coagulant. Without a knowledge of blood groups, transfusion was at best a hazardous operation, which might as readily result in the death of the patient as in the amelioration of his symptoms. Without citrate methods the technique of the operation was necessarily difficult owing to the risk of clotting.

Blood Groups—It has long been known that if the blood of one species of animal is injected into the circulation of another the injected corpuscles are rapidly destroyed and hæmoglobin appears in the blood and urine. The existence of "blood groups" in human beings was first shown by Landsteiner in 1901. In 1907 Jansky carried matters a stage further by describing four distinct groups. Two years later Moss made similar observations and published his classification of bloods into arbitrarily named Groups I to IV. The Moss grouping was widely used for many years, but should now be superseded by the International (A, B, O) Classification which is at last being universally adopted. These "four group" classifications depend upon the fact that all the red cells of any particular person carry both, one, or neither of two agglutinogens A and B, making four possibilities, AB, A, B, and O. Contact between cells carrying A or B and any serum containing the corresponding agglutinins termed respectively α and β , will result in agglutination of the cells. The blood of any individual cannot contain both agglutinin and corresponding agglutinin, otherwise auto agglutination would occur. Four stable mixtures may therefore be met with, namely, $AB+\alpha$, $A+\beta$, $B+\alpha$,

and $O+\alpha\beta$ These are the four main blood groups which for simplicity are in the International Classification named by their cell agglutinogens only. For bloods from different individuals to be completely compatible they must belong to the same group. Any other combination allows at least some of the cells to come in contact with their specific agglutinin. But in transfusion practice although it is essential that the incoming cells of the donor shall not be clumped by the recipient's serum, the agglutinins in the donor's serum are sufficiently diluted as they enter the recipient's circulation to reduce their effect on his cells to negligible proportions. Therefore it is possible to use as donors not only persons of the same group as the patient but also persons whose blood is of a group having cells which will be unaffected by the agglutinins known to be present in the patient's serum. The table given below will make the possibilities more clear. It indicates the result of contact between the cells of the possible donors and patients of different groups and the relationship between the older Moss Groups and the modern International Classification. It also shows the percentage occurrence of the groups in Western Europe. As Group O cells contain no agglutininogen they cannot be affected by sera of any of the groups. Persons belonging to Group O are therefore universal donors and used for building up stored blood supplies. For Group A

• Donor's Blood	Moss Groups	International Classification		Percentage Occurrence	RECIPIENT'S BLOOD			
		Agglutinogens in Cells	Agglutinins in Serum		Agglutinins in Serum			
					o	β	α	αβ
					Agglutinogens in Cells			
					AB	A	B	O
I	AB	o	7		+	+	+	
II	A	β	40		-	+	+	
III	B	α	10		+	-	+	
IV	O	αβ	43		-	-	-	

Table showing the result of the cells of donors of the various groups being brought into contact with the sera of the four possible types of recipient. A plus sign implies agglutination of the donor's cells a minus sign the absence of agglutination. The relationship between the International and Moss Classifications is shown, the percentage occurrence of the groups and also the agglutinogen agglutinin make up of each variety of blood.

patients the donor must belong to Group A or Group O for Group B patients the donor must belong to Group B or Group O Group AB patients can receive from donor of any group and Group O patients must have a Group O donor

Before transfusion therefore, it is essential to know the group of both donor and recipient. The technique of grouping using the "four group" classification is simple. Fresh high titre specimens of known Group A and Group B sera are required and can nowadays be obtained from the official serum laboratories. A little of the blood to be tested is collected from a finger prick into a tube containing a small quantity of 3 per cent sodium citrate. A drop of the cell suspension thus obtained is mixed on a perfectly clean glass slide with separate drops of the two known sera. The drops are kept under observation for ten to fifteen minutes, preferably at 37° C incubator temperature, but this warming is not usually necessary. When agglutination of the cells occurs they clump together the even emulsion taking on the appearance of coarse grains of red pepper lying in the clear serum. The change is readily seen with the naked eye when the slide is examined against a white background. By reference to the table it will be seen that should no agglutination occur with either serum, the cells tested are of Group O. If there is agglutination with both sera, the cells are of Group AB. If the cells agglutinate in serum A only they are of Group B. If they agglutinate in serum B only they are of Group A. In recent years it has been found possible to divide this last group into A_1 and A_2 . But this subdivision need not affect transfusion technique except in so far as occasional cases of Group A_2B have a serum which agglutinates O cells and thus introduces a slight risk of untoward reaction if a universal O donor is used for an AB patient without preliminary cross matching. For satisfactory grouping tests it is essential that the samples of standard sera should be quite fresh or have been kept in the ice chest because rapid deterioration takes place at room temperature.

As already explained, the ideal donor for any particular case is an individual of the same group. In these circumstances the two bloods will "cross match" perfectly, that is to say, no agglutination will take place when using the above slide technique, some of the donor's cells are mixed with the patient's serum and *vice versa* some patient's cells mixed with the donor's serum. To make quite sure of compatibility this test should always be made. When the donor, according to preliminary grouping is suitable but not of the same group as the patient one should by matching the donor's cells against the patient's

serum, make quite sure that the ingoing cells will not be agglutinated in the recipient's circulation. In some severe disorders of the blood and with all patients in whom it is undesirable to produce even the slightest reaction, it is advisable always to use a donor of the same group and one which cross matches perfectly. Occasionally cases are met with, particularly those with very severe anæmia, whose red cells undergo auto agglutination even in normal saline. It is then necessary to perform the cross matching tests at 37° C by keeping the cell serum suspensions in the incubator throughout the period of observation. In emergency and when no standard sera are available, and the precise groups of patient and donor cannot be determined, the finding that their bloods cross match perfectly, or even that the prospective donor's cells are unaffected by the patient's serum, will justify the transfusion being undertaken.

It is important to remember, while on the subject of blood groups, that in 1928 it was noted that one or both of two additional agglutinogens, termed M and N, may be present in human red cells. The corresponding agglutinins are not, however, found in any natural human sera. Therefore, no account need be taken of the M and N factors when groupings or matchings are made for blood transfusion purposes. But specific M and N agglutinating sera can be made by animal inoculation, and therefore by use of such sera, as well as known A and B human sera, twelve instead of four blood groups can be identified and termed AM, AN, AMN, BM, BN, BMN, OM, ON, OMN, ABM, ABN, and ABMN. This wider differentiation of blood samples has its obvious application in medico-legal work, but is unnecessary as a preliminary to blood transfusion.

Another factor Rh (*rhesus*), present in about 85 per cent of people, has recently been discovered, but as it is impossible in ordinary practice to test for this, it will suffice to say that it seems as though, for the ideal absence of risk, Rh patients should receive blood only from Rh donors, particularly if more than one transfusion has to be performed. Further work on this factor is awaited.

After any transfusion, even with a compatible blood, there is sometimes a general reaction with pyrexia and rigors, but if an incompatible group is employed there is a grave risk of serious symptoms. The recipient becomes rapidly distressed and dyspnoeic, suffers from precordial pain, and the pulse becomes first slow and then rapid and thready, the temperature rises and rigors may occur; the urine is diminished in amount, and sometimes hæmoglobinuria or suppression may occur.

Death may take place rapidly, often as the result of uræmia and deposition of altered hæmoglobin in the renal tubules. If, before transfusion, the patient is given sufficient alkali by the mouth to render the urine alkaline, this deposition of pigment in the renal parenchyma is, in event of incompatibility, largely prevented. The incidence of pyrexia and rigors can be decidedly reduced by (a) making sure that the blood is kept warm, its temperature never falling below 35°C , (b) the use of closed apparatus for transfusion and accessory solutions which are absolutely free from living or dead bacteria and all inorganic particles, and (c) giving the patient ephedrine $\frac{1}{2}$ gr twenty minutes before transfusion.

In addition to careful attention to grouping, it is important to ascertain that the donor is not suffering from any communicable illness such as syphilis, malaria, or fevers in the incubation period. Allergic donors are also undesirable.

The indications for transfusion are dealt with in the sections on various diseases, but they may be given here in tabular form.

1 Hæmorrhage and shock, *e.g.*, in severe trauma, operations, or loss of blood from hæmatemesis or hæmoptysis.

2 Blood diseases, *e.g.*, pernicious anæmia, splenic anæmia, leukæmia, *icterus gravis neonatorum*.

3 Hæmophilia and purpura, in which it is hoped that the transfused blood may bring about cessation of hæmorrhage.

4 Septicæmia and pyæmia.

5 Before operations upon anæmic patients.

Stored Blood—War conditions have directed increased attention to storing and transporting of blood for immediate transfusion of casualties. Whole, citrated blood collected from the donor with absolute asepsis into closed containers and stored at 2° to 4°C can be used without risk of undue reaction until about one month after collection. Shaking must be avoided. Good preservation of the cells depends also upon the exact composition and the amount of anticoagulant solution used. That which finds most favour for prolonged storage is 100 c.c. of 2.5 per cent sodium citrate and 20 c.c. of 15 per cent glucose for each 420 c.c. of blood. If, however, the blood is to be used within two or three days of collection, only 1 part of 3.8 per cent sodium citrate for each 9 parts of blood need be used. Then dilution being less, the oxygen-carrying power is greater. When stored for a long time by the former method the erythrocytes, although they slowly deteriorate losing potassium and tending to hæmolyse, remain capable of functioning physiologically in the recipient's circulation for

many days Maizels has shown that although the chemistry of stored cells differs from that of fresh they become reconditioned in the patient's circulation within twenty four hours of transfusion. But the longer the storage the more cells become changed beyond recovery and the more liable is transfusion to be followed by reactions the incidence of which steadily rises after the first fortnight of storage. Up to ten days however it may be assumed that all the transfused cells will become reconditioned and up to fourteen days storage that most of them will do so. The leucocytes of stored blood rapidly die and the platelets are lost by adhering to the sides of the container. Fresh blood should therefore be used for transfusing cases showing a poor white cell count and those suffering from active sepsis acute haemolytic anaemias or purpura. For other types of anaemia stored blood has great and satisfactory replacement value. Whatever antibodies are present are relatively well preserved and are transferred during transfusion.

For emergency work when grouping of the patient is impossible it is usual to store universal donor (Group O) blood only mixing several bloods together in order further to avoid incompatibility risks. But as some 40 per cent of the patients will belong to Group A a 'blood bank' generally carries a certain amount of Group A blood also for use in transfusions after the patient's group has been determined thus saving strain upon the universal donor panels. The disadvantages of Group O blood for universal transfusion are few but occasionally O plasma may be of exceptionally high titre and by agglutinating the cells of patients of groups other than O cause reactions. Except in the case of very anæmic patients whose cells must at all costs be protected this phenomenon is rarely of importance but whenever the red count is very low it is advisable to transfuse only with blood of the same group. This also applies to the use of plasma or serum.

During storage the cells settle after two days into a compact layer surmounted by relatively clear plasma. As red cell deterioration and haemolysis begin a pink zone appears in the lower part of the plasma and rises steadily but this zone should not be very noticeable until about the eighth day onwards. Gross haemolysis suggests infection of the blood. If the bottles are shaken after the cells have first settled the compact layer never reforms and the rate of haemolysis usually rises. If the blood is ever allowed to freeze rapid haemolysis takes place on thawing and if the blood be then transfused it may cause severe reactions. Although stored blood should be very

warmed to about body temperature before being run into a patient's vein, the greatest care must be taken that it is never at any time overheated. Overheating causes very rapid hæmolysis and extremely severe reactions. Whole blood transfusions, fresh or stored, are required only for casualties who have suffered actual hæmorrhage. If the condition is one of shock without hæmorrhage, they require transfusion of plasma or serum only.

Plasma Transfusion—Systematic storage of citrated blood provides opportunity to collect and store for even longer periods large quantities of plasma. This is easily pipetted from above the layer of cells, being withdrawn before any appreciable hæmolysis has taken place. Usually samples from several bottles are pooled. Drop transfusion of plasma is found to be particularly valuable when the patient is suffering from shock without hæmorrhage. The effect is to counteract the fall in plasma proteins to restore the blood volume, and to help to raise the systolic blood pressure to the region of 100 mm. of Hg. If plasma transfusion is going to be permanently effective in this respect, marked clinical improvement will have taken place by the time 2 or 3 pints have been run in. If the patient's condition is even then not maintained it is unlikely to be permanently benefited by further transfusion. The giving of very large volumes of Group O plasma is not without risk because, as noted in the previous section, its agglutinin content may be high. Group O plasma contains both agglutinins α and β , which in contact with any cells of groups other than O will agglutinate them rapidly. Using moderate quantities of pooled plasma this effect is rarely of clinical significance unless the patient's red count is exceptionally low but red cell destruction can be serious if really large volumes of high titre O plasma are given to patients of other groups. To avoid administration of the agglutinins in Group O plasma, it may be left in contact for some days with red cells carrying the agglutininogens A and B and its agglutinins will then be to a large extent absorbed. The agglutinin free plasma can then be stored in the usual way. The ideal plasma for transfusion is of course, Group AB, which is agglutinin free from the outset, but this unfortunately is the rarest group. Any plasma collected with strict asepsis may be stored wet for very long periods, although in the cold it tends to deposit fibrin gradually and requires, with the attendant risk of contamination, filtering at intervals. Thus it is customary to store plasma at room temperature under which conditions, although storage cannot be quite so long, fibrin deposit is much less marked.

Serum Transfusion—Stored serum can be used for all the purposes indicated above in connection with plasma. Plasma has no advantages over serum except that in practice particularly in the blood depots it provides a use for the plasma withdrawn from time expired blood. Experience in this country has not confirmed the suggestion that serum is more toxic than plasma though it is possible that very fresh serum is somewhat more toxic than the stored product toxicity gradually decreasing with keeping. Serum too goes flaky after long storage and all these stored materials should during intravenous administration always be passed through a monel metal gauze or a gas mantle filter as suggested by Maizels. All specimens which are not reasonably clear should be returned to the laboratory for bacteriological testing and refiltration. It is important to remember when considering the volumes to be transfused that owing to the preliminary dilution with anticoagulant the protein content of plasma is decidedly lower than that of serum. As regards rate of transfusion in the case of blood plasma or serum the first pint may be given relatively quickly in 20 mins say but thereafter the rate should be reduced to about one drip per second or even slower.

Desiccation of Serum and Plasma—Although serum and plasma can be stored wet for very long periods drying *in vacuo* at low temperatures is the only means of ensuring really permanent preparations. Another great advantage possessed by the dried products is the enormous reduction in volume and the ease with which they can therefore be transported great distances. Wet preparations would not be so extensively used as they are at present if there were more drying plants in the country. On the other hand for a hospital having its own local donor panel and using the plasma or serum in its own wards desiccation is really unnecessary. The transport question does not arise time and some trouble are involved in redissolving the dried products and blood collection is graded to the purely local needs and very long storage is never necessary.

Transfusion of Red Cells Alone—If blood collected as for storage (citrate and glucose) is left for two to five days in the cold until the red cells have settled into a compact layer the plasma may be pipetted off to within one quarter of an inch of the upper level of the cells. These can then be transfused alone. Administration should follow separation within twenty four hours in case the blood has been infected during removal of the plasma. For the same reason the cells should be kept cold until just before use. The advantages which may be in the transfusion of these packed cells are that much oxygen

carrying capacity is provided in small bulk, any agglutinating action of the Group O plasma upon the patient's cells is largely removed and when, as in a case of aplastic anæmia, the patient may require, say, 400 c.c. of cells per fortnight, the plasma which the patient does not in any case need is saved for other purposes.

Method of Blood Transfusion—The technique of blood transfusion can only be learnt by experience. The citrate method is that usually adopted, a pint of the donor's blood is withdrawn through a large needle into a flask containing approximately 75 c.c. of 3.8 per cent sterile sodium citrate, as the citrate prevents clotting, the blood may, provided it is protected throughout from contamination by dust or bacteria, be run into the recipient's vein at leisure by any method employing gravity or syringe pressure. If the citrate is an absolutely pure product, it appears to produce no ill-effects. The essential points concerning grouping, temperature control and reactions have been considered in earlier sections. As regards method the gravity apparatus issued for Service and E.M.S. emergency work is very valuable owing to its extreme simplicity, but with difficult veins or those of young children, methods in which the operator has greater personal control such as the two way syringe or small rotary pump methods, are more reliable and better adaptable to difficult clinical conditions. Also where large volumes are to be given very slowly by drip over long periods it will be found better to use when possible, a more refined apparatus than that now issued for emergencies. For details of these methods the reader should refer to works devoted to actual technique.

ANÆMIA

A diagnosis of "anæmia" is one that is often too readily made by the patient and sometimes by the medical attendant. It must be remembered that too much reliance must not be placed upon the patient's colour, for it is not unusual to find persons with a preternaturally pale complexion whose blood as proved by estimation of the hæmoglobin, shows no evidence of anæmia. The best clinical indication of anæmia is pallor of the conjunctivæ, the nail beds, and of the palms of the hands. Needless to say, before instituting treatment for anæmia, a careful blood examination is essential.

Classification of Anæmia—Anæmia may be due to loss or increased destruction of blood, or it may result from interference

with the production of red cells. The following classification of the more common types of anæmia may be adopted

1 Anæmia due to loss of blood or increased blood destruction

- (a) Hæmorrhage, acute or chronic
- (b) Abnormal hæmolysis, this includes acholuric jaundice, sickle celled anæmia, and the acute hæmolytic anæmia of Lederer. Hæmolysis also occurs in malaria, blackwater fever, and some times in septicæmias

2 Anæmia due to interference with normal blood formation

- (a) Toxic or infective processes, *e.g.*, lead poisoning, nephritis, growths, acute or chronic infections
- (b) Deficiency anæmias pernicious anæmia, simple achlorhydric anæmia, and perhaps chlorosis

Obviously in any individual patient more than one factor may be producing anæmia, thus carcinoma ventriculi may render the patient anæmic by continued loss of small amounts of blood, and also by its depressant effects on the bone marrow and the reduced production of the gastric hæmopoietic factor. The term "secondary" is often applied to any form of anæmia in which the colour index is low, but it is desirable to abandon this in favour of the term "microcytic" or "hypochromic," indicating that the red cells are smaller than normal and contain less hæmoglobin in contrast with the "megalocytic" or "hyperchromic" types in which the cells are on the average larger than normal and contain more hæmoglobin.

ANÆMIA DUE TO HÆMORRHAGE

Very severe anæmia may result from either a single severe hæmorrhage, or from long continued loss of smaller amounts of blood. As a rule the diagnosis is obvious, but it is important to bear in mind that bleeding from piles or from the uterus may produce a severe anæmia, though the amount of blood lost at any one time may not be very great. Treatment must be directed to the cure of the underlying condition, though in severe cases blood transfusion may be required to tide over a critical condition. Administration of iron (*vide p. 356*) accelerates the regeneration of the blood.

ACHOLURIC JAUNDICE

This condition is also sometimes known as Chronic Hæmolytic Jaundice. It occurs in a familial form, but there is also

an acquired hæmolytic jaundice in adults. How far these two types are related remains uncertain.

In both forms of acholuric jaundice the fragility of the red cells is usually increased, but more obviously in the familial cases. Normal red cells begin to hæmolyse in a saline solution of 0.45 per cent, and hæmolysis is complete in a 0.3 per cent solution. In acholuric jaundice the corresponding figures are 0.6 per cent and 0.40 per cent. In acholuric jaundice the increased fragility of the corpuscles leads to their premature destruction, and the liberated hæmoglobin is transformed into bilirubin and jaundice results. The main site for the destruction of corpuscles is the spleen. There is an excess of urobilin in the urine, but no bile. In some cases of the disease, particularly in its acquired form, there may be no evidence of increased fragility, as judged by testing with saline solutions, but in some of these the fragile nature of the cells may be demonstrated by washing the cells completely free of serum before applying the test.

Symptoms—In the familial form of the disease jaundice may be first noted in infancy or childhood. The spleen is much enlarged. The anæmia is only of moderate degree and gives a false appearance of microcytosis because of the spherical shape of the red cells in acholuric jaundice (spherocytosis). The symptoms are often intermittent, and the general health may remain satisfactory. Exacerbations occur in which the patient becomes more obviously jaundiced and anæmic, and during these periods there may be some pyrexia, with petechial hæmorrhages and ecchymoses.

In the acquired type, which starts in adult life, the anæmia is more severe and the jaundice less striking.

In both forms of acholuric jaundice the reticulocytes are increased, particularly in the acquired type, to 15 per cent or higher, indicating active generation of new red cells to replace those lost by hæmolysis. The indirect van den Bergh reaction is positive, very markedly so during the active phases, owing to the hæmolysis, and pigment stones may form in the biliary tract and give rise to biliary colic. The leucocyte count is usually increased during exacerbations.

Diagnosis—Acholuric jaundice may be mistaken for pernicious anæmia. In the latter condition, however, there is diminished rather than increased fragility and the blood picture is megalocytic, in contrast to the low colour index in acholuric jaundice. Moreover, the spleen is rarely as large in pernicious anæmia as in acholuric jaundice.

Treatment—In some of the familial cases the symptoms are so slight that no treatment is needed. In both types of the disease splenectomy usually produces remarkably good results. Soon after the operation the fragility is often diminished, but later the condition of increased fragility may reappear, although the patient no longer suffers from the symptoms of the disease.

Sickle-celled Anæmia—This is a familial and hereditary disease found only in negroes. There is intermittent fever and severe hæmolytic anæmia, which ultimately proves fatal. Large numbers of the red cells are sickle shaped. No treatment is effective.

Acute Hæmolytic Anæmia of Lederer.—Nothing is known of the ætiology of this rare condition, which usually occurs in adolescence. The onset is sudden and the degree of anæmia increases rapidly. The temperature is raised and hæmoglobinuria or slight jaundice may occur. There is often a leucocytosis with myelocytes or myeloblasts simulating acute leukaemia. Transfusion is often successful and this may help to differentiate the condition from leukaemia.

PERNICIOUS ANÆMIA

(*Addison's Anæmia*)

Addison, in 1849, described by the term 'idiopathic anæmia' a condition of profound anæmia occurring without any obvious loss of blood. This well recognised clinical condition has since been generally known as pernicious anæmia. The disease occurs rather more commonly in males than in females, and is most likely to develop between thirty five and sixty years of age. It is sometimes hereditary or familial.

Morbid Anatomy.—There is little evidence of emaciation in comparison with the duration and severity of the anæmia. The post mortem findings are characteristic. The skin is usually of a typical lemon yellow tint, with occasionally a few petechial hæmorrhages on the lower limbs. The muscles are intensely red while the subcutaneous fat is of a bright yellow colour. The heart is markedly flabby, with much fatty infiltration of the muscle, on naked eye examination this is best seen beneath the endocardium covering the *musculi papillares* of the left ventricle, the condition being usually termed 'tabby cat striation'. The liver is often large and fatty, with a colour exactly that of *café au lait*. With potassium ferrocyanide and hydrochloric acid the liver turns a Prussian

blue colour, due to an excess of iron containing hæmosiderin. This reaction is known as Perl's test, and is usually also positive in the kidneys and spleen. The latter organ is enlarged in a majority of the cases. The bone marrow in the shafts of the long bones is bright red in colour, and a smear of the marrow shows numerous large nucleated red cells. The spinal cord appears normal on naked eye inspection, but histological examination may show the changes characteristic of subacute combined degeneration.

Pathology—For effective maturation of the red cells in the bone marrow an anti-anæmic principle is necessary. To produce this it has been shown by Castle that two factors are required: (i) an intrinsic factor (hemopoietin), which is produced by the gastric mucosa, especially that of the pyloric antrum and to a less extent by the cardiac and duodenal mucosa. The intrinsic factor is thermolabile. (ii) An extrinsic factor, which is present in the protein of the food, especially in that of meat or perhaps in the breakdown products of such proteins. The intrinsic and extrinsic factors are both necessary for the production of the "anti-anæmic principle" which at any rate when stored in the liver is thermostable. This is formed by the interaction of the two factors and is absorbed from the small intestine into the blood, which carries it to the liver and other organs, where it is stored, particularly in the liver. Without the 'anti-anæmic principle' the red cells in the bone marrow are incapable of normal maturation. In consequence of such impaired maturation the circulating red cells are larger than normal and the anæmia produced is megalocytic or hyperchromic.

Megalocytic anæmia may result from (i) absence or insufficiency of the intrinsic factor, (ii) insufficiency of extrinsic factor, (iii) inability of the intestine to absorb the anti-anæmic principle formed by the two factors, (iv) a failure of the storage mechanism in the liver, (v) a failure of the bone marrow to make effective use of the anti-anæmic principle.

By far the most frequent cause of megalocytic anæmia is the first, absence or insufficiency of the intrinsic factor, and this is the basis of the relatively common disease, pernicious anæmia.

As has already been stated the intrinsic factor is evolved in the gastric mucosa, mainly in the prepyloric region. If the intrinsic factor is absent or deficient the supply of anti-anæmic principle to the marrow is rendered deficient. In the aetiology of pernicious anæmia it is necessary to determine how the supply of intrinsic factor comes to be defective. In

pernicious anæmia it has been shown that almost without exception there is a gastric achylia, in which there is no secretion of free hydrochloric acid even after stimulation by histamine. Such an achylia may result from an hereditary defect in the stomach. Thus it is found that not infrequently the disease is familial and also that in a family where one member has pernicious anæmia others may show gastric achylia. Moreover, many patients who develop pernicious anæmia have been known to have been achylic for years before the anæmia develops. Nor does the achylia disappear during remissions of the anæmia whether spontaneous or induced by liver treatment. It is clear, therefore, that the achylia which is such a constant feature of pernicious anæmia is not the result of the anæmia, but is in some way related to its development. Yet there must be other factors necessary for the development of the disease besides achylia for it is known that this anomaly is not uncommon often without producing symptoms of any kind. It is probable that the functions of the gastric mucosa are threefold, the secretion of hydrochloric acid of enzymes, and of the intrinsic factor. It is clear therefore that an inability of the mucosa to produce acid or even enzymes, though this may constitute an achylia, is insufficient to cause pernicious anæmia unless the intrinsic factor is also absent.

Other factors apart from an hereditary defect in the stomach may much more rarely produce achylia and pernicious anæmia. Thus surgical removal of a large portion of the stomach, particularly the pyloric area, may occasionally be followed by pernicious anæmia. It may also result from damage to the mucosa by chronic gastritis and when the pyloric portion of the stomach is destroyed by carcinoma, anæmia of the pernicious type may ensue.

Megalocytic anæmia may also result from a deficiency in the extrinsic factor. This may be the underlying cause in the so called tropical anemias, but it is doubtful whether it arises in non tropical countries. A more frequent cause of megalocytic anæmia is failure of absorption of the anti anæmic principle. This may occur with strictures of the intestine usually tuberculous or where abnormal anatomical conditions have arisen such as a gastro colic fistula. It is also likely to explain the megalocytic anæmia of sprue (*vide p 195*) for in this disease absorption from the intestine is defective.

Storage of the anti anæmic principle may be ineffective in widespread disease of the liver such as cirrhosis. In the rare form of megalocytic anæmia known as *achrestic anæmia* there is probably some faulty mechanism in the bone marrow, which

fails to respond even to adequate amounts of the anti-anæmic principle

Occasionally a pernicious type of anæmia is seen during pregnancy, or shortly after delivery. Its cause is doubtful but it usually reacts to liver treatment, though sometimes whole liver taken orally seems more effective than parenteral liver extract

Subacute combined degeneration of the cord is a frequent accompaniment of pernicious anæmia, and this condition may sometimes occur before anæmia becomes manifest. It is likely that the stomach secretes not only the intrinsic factor, which with the extrinsic factor produces the anti-anæmic substance, but also some other enzyme which is essential for the adequate nutrition of the nervous tissues. This hypothetical enzyme has been termed "neuropoietin"

Sepsis, such as infected tonsils or teeth, diminishes the effectiveness of liver in the treatment of pernicious anæmia. Possibly sepsis may in itself have a depressant effect on the hæmopoietic functions, tending to produce and maintain gastritis, or it may to some extent directly interfere with the absorption of the anti-anæmic substance

While there is no true hæmolysis in pernicious anæmia the van den Bergh test shows a positive indirect reaction. This is due to a failure of utilisation of the breakdown products of normal red cell destruction, and possibly the failure of excretion of these products owing to fatty changes in the liver

Symptoms—The symptoms and signs fall into two main groups: those resulting from the profound anæmia and resembling those found in other anæmias, and those which are more or less characteristic of pernicious anæmia. In the former group are such symptoms as dyspnoea, muscular weakness, headaches, palpitation, anginal pain, and oedema of the ankles, and among physical signs a systolic hæmic murmur in the pulmonary area. The symptoms and signs characteristic of the disease are as follows:—

1 *Skin*—The great majority of patients show a typical lemon yellow tint, which, together with the positive indirect van den Bergh reaction, may disappear during remissions, but which is nearly always present at some stage of the disease. In addition brown pigmentation is not uncommon. Occasionally pigmentation may occur in the mouth.

2 *Gastro-intestinal Symptoms*—Vomiting, diarrhoea and dyspepsia are common and may occur in the earlier stages before the anæmia is severe or even for years before it develops

Gastric achlorhydria is a constant feature, not only during the more acute stages but also during remissions. The significance of this has already been discussed. The tongue is frequently red, smooth, and devoid of papillæ, and the patient complains that it is very sore. In contrast to other anæmias, constipation is very unusual.

3 *Neurological Symptoms*—Subacute combined degeneration of the cord is described on p. 916.

4 *Spleen*—This organ is palpable during life in at least half the cases, but it is rarely very large.

5 *Pyrexia*—Most cases of untreated pernicious anæmia have a low, irregular pyrexia, which is often intermittent.

6 *Eyes*—Retinal hæmorrhages occur in severe cases.

7. *The Blood Picture*—The most characteristic feature of the blood is that the average size of the red cells is increased. Normal red cells average 7.4μ in diameter, while in pernicious anæmia this figure may be as high as 9.40μ . A similar blood picture is seen in other forms of macrocytic anæmia. These include pernicious anæmia of pregnancy, tropical nutritional anæmia, sprue and the anæmia due to *Dibothriocephalus*. The increased mean diameter of the red cells explains the high colour index which is nearly always found in the disease. By this term is meant the ratio between the hæmoglobin percentage and the percentage of the red cell count as compared with theoretical normals of 100 per cent Hb (14.7 mg Hb per 100 c.c. of blood) and 5,000,000 cells to the cubic millimetre (see p. 335).

$$CI \text{ (colour index)} = \frac{\text{Hæmoglobin percentage}}{\text{Red corpuscle percentage}}$$

For example, with a red cell count of 1,000,000 and a hæmoglobin percentage of 25, the colour index $= \frac{25}{20} = 1.25$,

because 1,000,000 red cells represent 20 per cent of the average normal count of 5,000,000. A colour index above unity indicates that the average size of the cells is above normal, while with a low colour index the cells may be of normal size with a diminished content of hæmoglobin (hypochromic) or may be actually smaller than normal (microcytic).

Although the average size of the red cells is large, there are also many abnormally small cells, and the variation in size is termed *anisocytosis*. The cells are also irregular in shape, a condition known as *poikilocytosis*. Basophil granules and "steel" blue staining of the cells occur, termed respectively *punctate basophilia* and *polychromasia*. During the later stages

in the disease, many nucleated cells appear in the peripheral circulation, when of normal size these are described as *normoblasts*, but larger and extremely primitive forms termed *erythroblasts* and *megaloblasts*, may finally appear. Megaloblasts are rarely seen except in advanced cases of pernicious anaemia and are not necessarily found in every case.

The hæmoglobin percentage may fall to under 20 per cent and the red cell count below 1,000,000, but even in the earlier stages the nature of the anaemia is suggested by the megalocytosis, high colour index, and the positive indirect van den Bergh reaction.

The leucocyte count is always low except in the presence of a secondary infection, and seldom rises above 5,000 cells to the cubic millimetre. The differential count shows a diminution in the polymorphonuclear cells, with a relative increase in the lymphocytes. The polymorphs show a "shift to the right" (*vide p. 333*). The blood platelets are usually reduced.

Diagnosis—In most cases the diagnosis can be made on clinical grounds, but a careful blood examination and the discovery of achlorhydria confirm the diagnosis. The disease with which pernicious anaemia is most likely to be confounded is carcinoma of the stomach. In the latter condition, however, the anaemia is usually of the microcytic type, with a low colour index, and although achlorhydria may be present there is often blood in the test meal, but in a few instances a pernicious type of anaemia has been known to develop. The presence of a palpable tumour, marked emaciation, and X-ray evidence will usually reveal the true diagnosis. The anaemia of sprue may exactly resemble that of pernicious anaemia, but the character of the stools and residence in the East will provide a clue. Severe secondary anaemias due to loss of blood present a completely different clinical picture and rarely give rise to serious difficulty. In simple achlorhydric anaemia (*vide p. 334*) the blood picture is of the microcytic type and the condition reacts rapidly to treatment with iron.

Treatment—It has already been stated that the administration of liver is a specific in pernicious anaemia. At the present time many extracts of liver suitable for intramuscular injection have been put on the market under trade names such as Anahæmin, Pernæmon, and Hepatex. The dosage of such preparations varies with the concentration of the particular extract and they have entirely replaced the oral administration both of liver or liver extract. It has been found, however, that these highly purified extracts are often less efficacious

than the cruder preparations of liver, when used in the treatment of other macrocytic anæmias, such as tropical nutritional anæmia. In this condition there is often a deficient diet, and marmite is often as effective as liver.

Intramuscular injections have many advantages over oral administration, firstly, they are very much cheaper than adequate amounts of liver given orally. Secondly patients readily tire of eating liver and consequently may omit to do so a course which inevitably leads to relapse. Intravenous injection is usually both unnecessary and dangerous, as the extracts are difficult to purify and may produce profound shock if given intravenously.

When the patient is severely anæmic, liver extract should be given daily by intramuscular injection, the dose varying from 2 to 5 cc according to the preparation employed. When the clinical condition has improved and the hæmoglobin has risen to 50 per cent the frequency of the injections can be cautiously cut down. When the hæmoglobin has risen to 100 per cent the blood should be maintained at this level by injections at intervals of several weeks. It is important to stress to the patient that treatment must be continued for the rest of his life, otherwise relapse is certain.

It is important to have the blood examined at least every two months after recovery from the anæmia. Otherwise the patient may develop insidiously a considerable degree of anæmia or subacute combined degeneration. If the hæmoglobin falls, more intensive liver treatment is required.

Striking changes in the blood occur with the institution of liver treatment, and the more anæmic the patient the more effective is the liver. The first indication that liver is producing an effect is the appearance of an increased number of reticulocytes in the blood. In the untreated patient with pernicious anæmia, reticulocytes (*vide* p. 333) seldom exceed 1 to 3 per cent of the red cells. Within about five days of starting liver treatment the number of reticulocytes increases, and by about the tenth day of treatment they have usually risen to between 15 and 40 per cent. Concurrently with the increase of reticulocytes, or as it is often called a reticulocyte response, there is a rise in the percentage of hæmoglobin and in the red cell count. After about the tenth day of treatment the reticulocytes begin to diminish in number, and after some weeks have returned to their normal figure. The hæmoglobin and red count, on the other hand, continue to rise, and within about eight to ten weeks may have reached normal figures. During liver treatment the leucocyte count

ries. The red cells become normal in size and shape and the colour index approximates to unity.

With the changes in the blood there is a rapid improvement in the condition of the patient. The lemon yellow tint of the skin disappears and the indirect van den Bergh test becomes negative. Weakness, breathlessness, and depression are replaced by a feeling of well being and the appetite increases. Subjective symptoms due to subacute combined degeneration, such as numbness and tingling in fingers and toes, disappear, but when there are objective symptoms of structural nervous disease such as extensor plantar responses, these are little affected by liver treatment, though there may be a remarkable improvement in the clinical condition (*vide p. 918*).

Even though the patient may improve rapidly under the influence of liver, it is essential to insist upon adequate rest in bed, particularly when the percentage of hæmoglobin has been below 30 per cent. The patient should not be allowed up until the hæmoglobin reaches 70 per cent. As soon as he is sufficiently fit any infective foci, such as teeth or tonsils, should be dealt with.

Blood transfusion is now very rarely necessary in pernicious anaemia, and should only be employed if the patient is in *extremis*.

Desiccated stomach may be given in addition to liver. Several commercial preparations of dried hog's stomach are on the market under trade names such as Pepsae and Ventriculin. They are given by mouth in doses up to 1 oz a day and are said to be of special value in the treatment of subacute combined degeneration.

Iron has no specific effect on pernicious anaemia, but when the anaemia is severe it may be given (*vide p. 36*) for the manufacture of hæmoglobin.

Plenty of fresh air, sunshine, and a liberal mixed diet of adequate vitamin content should be ensured.

Prognosis—In the past pernicious anaemia justified its sinister name and was almost invariably fatal within a few years, though usually there were several remissions either spontaneous or induced by transfusions. With liver treatment the outlook has entirely changed and with proper care there would appear to be no reason why a patient with pernicious anaemia should not live an active and useful life for an indefinite period provided adequate treatment with liver is continued.

IDIOPATHIC HYPOCHROMIC ANÆMIA

This form of anaemia, which is also sometimes described as Simple Achlorhydric Anaemia, is of frequent occurrence in women of middle age and rarely, if ever, is found in males.

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IDIOPATHIC HYPOCHROMIC ANÆMIA

This form of anæmia, which is also sometimes described as Simple Achlorhydric Anæmia, is of frequent occurrence in women of middle age, and rarely, if ever, in men

Ætiology—Idiopathic hypochromic anæmia is so called because the corpuscles contain less hæmoglobin than normal. It is the result of a deficiency of iron, either owing to lack of iron in the diet or more often to imperfect absorption of the metal. Menorrhagia probably plays a part in its production. Achlorhydria, or at any rate extreme hypochlorhydria, is an almost constant finding, and it is probably owing to this that absorption of iron is defective. The condition is sometimes familial and examples of pernicious anæmia and idiopathic hypochromic anæmia may be found in a single family. Probably the explanation of this fact lies in an inherited tendency to achlorhydria or gastritis in certain families. The condition, though often unrecognised, is very common and a frequent cause of chronic ill health.

Symptoms—These will depend on the degree of anæmia and include lassitude, breathlessness, precordial pain or palpitation, digestive disturbances such as flatulence and discomfort, anorexia, and pallor, which, however, even when severe has not the yellow tinge of pernicious anæmia. The nails are often atrophic and spoon shaped (koilonychia). The tongue may be smooth and atrophic and cracks may occur at the corners of the mouth (perlèche). The spleen is sometimes slightly enlarged.

In a proportion of cases the patient complains of a difficulty in swallowing localised to the lower pharyngeal region. This is probably due to a failure of relaxation of the sphincter formed by the lower division of the inferior constrictor muscle of the pharynx, analogous to that which occurs in achalasia of the cardia. Dysphagia of this type in anæmia is often described as the Plummer Vinson syndrome. It can be relieved by passing a thick rubber mercury bougie, and it disappears when the anæmia is abolished by treatment with iron.

The blood count is not characteristic, but the colour index is always low, usually about 0.5 to 0.6. The average red count is 3 to 4 millions and the hæmoglobin 40 to 50 per cent. The leucocyte count is normal. The red cells are usually smaller than normal. There is no hæmolysis and the van den Bergh reaction is negative.

The condition is an extremely chronic one and patients have often been known to have suffered from anæmia for years before a definite diagnosis is made.

Diagnosis—Idiopathic hypochromic anæmia must be differentiated from anæmia due to organic disease, such as carcinoma or chronic hæmorrhage. A careful clinical examination and investigations are important to exclude such causes.

for the anæmia Pernicious anæmia has a completely different blood picture

Treatment—Iron, provided it is given in sufficiently large doses, is as specific in the treatment of idiopathic hypochromic anæmia as is liver in pernicious anæmia. It must be given in doses at least twice as large as the maximal pharmacopœial dose, and should always be given by mouth. Injections of iron are either ineffective or dangerous. The best preparation is iron and ammonium citrate, of which at least 90 gr should be given in the twenty four hours. The drug is best given as a saturated solution in 20 to 30 minims doses thrice daily taken in a small quantity of milk. This masks the astringent taste. Bland's pill (Pilula Ferri B.P.) is an alternative. The pills must be fresh and three or four of the 3 gr pills should be taken thrice daily. Liver is ineffective and the anæmia is very rarely severe enough to justify transfusion.

Chlorosis—This form of anæmia was extremely common until thirty years ago among adolescent females but it is now never seen probably as a result of improved conditions of life. It was characterised by an anæmia with low colour index and a greenish tint of the skin. It was often associated with digestive disturbances and hyperchlorhydria. Like idiopathic hypochromic anæmia, chlorosis responded readily to iron.

APLASTIC (DYSHEMOPOIETIC) ANÆMIA

In this form of anæmia there is a failure on the part of the bone marrow to produce properly formed the elements of the blood, including red cells, white cells, and platelets. The erythropoietic tissue is chiefly involved. The *toxic form* of aplastic anæmia may result from the effects of certain poisons on the bone marrow such as benzol, occasionally arsphenamine and other arsenicals, radium, X rays and thorium. A few cases of the idiopathic form are met with in which there is no obvious cause. The bone marrow is fatty and atrophic. Fortunately aplastic anæmia is a very rare disease.

The symptoms are those of a profound anæmia, the colour index is usually about unity and the white count is low. The platelets may be also much diminished, in which case hæmorrhages and petechiæ are a prominent feature, as in thrombocytopenic purpura. Progress is nearly always steadily downhill, and liver and iron produce no beneficial effects. Blood transfusion is of temporary benefit, and a few instances are on record in which there has been some recovery in hæmopoietic

functions, but usually within a few weeks the anæmia becomes as severe as ever. A few patients with the disease have been kept alive for several years by transfusions at about fortnightly intervals. Owing to the very low white count and inability to produce a physiological leucocytosis, patients with aplastic anæmia have very poor resistance to infections and readily succumb to them.

Secondary carcinomatous deposits in the bone marrow may result in (a) the appearance of a few immature malformed red or white cells in the circulating blood and (b) actual replacement of the hæmopoietic tissue by the neoplasm may later also produce an anæmia of the aplastic type. Osteosclerosis, occurring in various conditions in which the bone marrow is encroached upon by proliferating connective tissue and newly deposited bone, may have similar effects upon the blood picture. Both these types of anæmia are sometimes described as myelophthisic anæmia. Chronic sepsis or nephritis may markedly inhibit erythropoiesis. Similar effects may be seen in lack of vitamin C (scurvy) and thyroxin deficiency (myxædema).

ANÆMIA IN INFANCY AND CHILDHOOD

In infancy anæmia may result from failure of nutrition, infections, or hæmolysis. Nutritional anæmia of mild degree is common in bottle fed babies as a result of deficiency of iron. Anæmia may also occur in rickets. A condition known as von Jaksch's anæmia occurs between six and twenty four months of age, but it is doubtful whether it is a genuine clinical entity. The spleen is extremely large and there is severe anæmia with a low colour index. The total leucocyte count is high—usually 20,000 to 30,000—and variable numbers of myelocytes are present. This has given the condition its alternative title of Pseudo leukæmia Infantum. Transfusions, iron, and liver are all of value, and complete recovery eventually occurs, *unless death results from intercurrent infection*.

There are no special types of anæmia in childhood, but children are more prone than adults to hæmolytic anæmia such as acholic jaundice (*vide p. 345*). Anæmia may also be secondary to coeliac disease or Hodgkin's disease. Blood pictures in childhood are often confusing, and myelocytes may appear quite apart from leukæmia.

The very severe anæmias occasionally seen in the earliest days of life have been classified as (a) congenital hydrops, (b) icterus gravis neonatorum. In the first the child is born

with a severe hypochromic anæmia with many immature red and white cells, generalised œdema and effusions, and organs which histologically show widespread extramedullary attempts at blood production. No treatment is successful. In icterus gravis neonatorum there is severe, usually hyperchromic anæmia with many nucleated red cells, extramedullary hæmopoiesis, rapidly deepening jaundice, enlarged liver and spleen, petechial hæmorrhages, but no œdema or effusions. Early and frequent small blood transfusions, 30 to 50 c.c. of blood at a time, will usually save the infant, and success has also been obtained by repeated intramuscular injections of normal human serum.

AGRANULOCYTOSIS

The term agranulocytosis indicates a condition in which there is an absence of, or a great diminution in, the granular forms of leucocytes. The total white cell count is low and the polymorphonuclear cells may be reduced to 5 per cent or less. In conjunction with this agranulocytosis the patient suffers from severe ulcerative and necrotic inflammation, most commonly seen around the fauces and buccal cavity, but sometimes in other regions, such as the rectum or vagina. The onset of symptoms is usually sudden, though the patient may have been in poor health for some time. The temperature is raised and the constitutional symptoms severe. Death often occurs within a week. In view of the frequency of ulceration in the throat, the condition is sometimes described as agranulocytic angina.

The agranulocytosis probably precedes the necrotic lesions, which occur as a result of secondary infection owing to the patient's diminished powers of resistance. The absence of granular white cells in the blood may be due to interference with the maturation of the precursors of the granular leucocytes in the bone marrow. The factors which influence the bone marrow are unknown, but in a large proportion of cases of agranulocytosis drugs appear to be the chief ætiological factors. There is much evidence that the condition may follow the taking of amidopyrine (pyrimidon) or preparations which contain amidopyrine. The sulphonamide group of drugs may cause agranulocytosis (*vide p. 71*). Agranulocytosis occasionally occurs after administration of arsphenamine, sandoesin, and other preparations of gold. In recent years the condition has become much more common, possibly due to widespread use of sulphonamides.

The mortality of agranulocytosis is high probably between 40 and 80 per cent. Blood transfusion may be used as a temporary measure. Stimulating doses of X rays to the long bones have sometimes produced a rise in the granular elements of the blood and a remission of symptoms. Perhaps more valuable is Pentnucleotide, which stimulates the bone marrow to produce granulocytes. The drug is available in 10 *ê c* ampoules each containing 0.7 grm. One ampoule is injected intramuscularly twice a day until the leucocyte count begins to rise. This may be expected to occur in four or five days. Subsequently one ampoule a day is given until the count reaches normal figures.

Needless to say, in every case of agranulocytosis it is essential to ascertain that the patient is not taking on his own account any of the drugs which might give rise to agranulocytosis.

PURPURA

There are many conditions in which hæmorrhage may occur in the skin, from the mucous membranes, in the joints, or indeed in any organ of the body. At the present time our knowledge of the pathology of such hæmorrhagic states is very incomplete, and it is therefore difficult to draw up any satisfactory classification on an ætiological basis. The following provisional classification is based chiefly on clinical experience.

1 Symptomatic purpura. This may occur in infections, *e.g.*, septicæmia, subacute bacterial endocarditis, cerebrospinal fever, and the hæmorrhagic forms of the specific fevers. It also occurs in toxic conditions, *e.g.*, uræmia, cirrhosis of the liver, and severe anæmias and leukæmias.

2 Purpura hæmorrhagica or thrombocytopenic purpura.

3 Hereditary hæmorrhagic states. (1) hæmophilia (2) hereditary telangiectasia, (3) hereditary purpura hæmorrhagica.

4 Anaphylactoid purpura. Henoch's and Schönlein's purpura.

Hæmorrhage may obviously result from a number of factors, concerned either with the blood itself or some alteration in the permeability of the capillaries. It is not necessarily in association with failure of the blood to clot. Indeed, in most forms of hæmorrhage, except in hæmophilia, there is no prolongation of the clotting time. Diminution in the number of platelets may be associated with a tendency to hæmorrhage, and in the severe form of purpura, often known as thrombocytopenic, the platelets may be practically absent. Hæmorrhage of the purpuric type is, however, not necessarily associated with a decrease in the number of platelets. Thus in anaphylactoid

purpura the fault is probably an increased permeability of the capillary wall, and the condition may be allied to urticaria. The underlying cause of thrombocytopenia (diminution in the number of platelets) is as yet uncertain.

SYMPTOMATIC PURPURA

Little is known of the pathological changes associated with symptomatic purpura. The platelets may be decreased, normal, or increased in number. Probably the purpura is due to changes in the walls of the capillaries, induced perhaps by infection or toxæmia. The variations in the platelet content of the blood may be purely a secondary result of the hæmorrhage. Symptomatic purpura may occur in the following conditions —

1 *Infections* —Most of the specific fevers, such as measles and smallpox, have hæmorrhagic forms, fortunately rare, in which hæmorrhage occurs in the skin and elsewhere. In cerebrospinal fever cutaneous hæmorrhages are relatively common and have given the disease its name of spotted fever. Purpura in the form of petechiæ and ecchymoses is common in streptococcal and staphylococcal septicæmia. It also occurs in subacute bacterial endocarditis, where it may be the result of minute infarcts.

2 *Toxic Disturbances* —Purpura may be present in uræmia, cirrhosis of the liver and in advanced malignant disease.

3 *Poisons* —Arsphenamine and sanocrysin may produce purpura, but probably only in persons who are in some way sensitive to the drug.

4 *Severe Anæmia* —In severe anæmia of all types cutaneous hæmorrhage is not uncommon. This is specially true of the acute leukæmias, aplastic anæmia, and pernicious anæmia.

5 *Vitamin Deficiencies*.—Scurvy, both adult and infantile.

PURPURA HÆMORRHAGICA

This condition is also termed Thrombocytopenic Purpura or Essential Thrombocytopenia, owing to the fact that the platelets are much diminished in numbers. The disease varies very greatly in its degree of severity. The part played by the platelets is unknown, but, at any rate during periods of hæmorrhage, they are extremely reduced in the blood. The coagulation time of blood collected in a tube is normal, i.e., about three and a half to four minutes at 37° C, but the bleeding time (*vide p. 334*) is much prolonged, if at the time it is

tested the patient is suffering from hæmorrhage. Normally the bleeding should cease within about three to four minutes. In purpura hæmorrhagica it may be sometimes observed to continue four or five times as long.

Symptoms.—Purpura hæmorrhagica occurs both in an acute and chronic form. In the former the onset may be very abrupt with profuse hæmorrhage, which renders the patient dangerously anæmic within a few hours. The bleeding may be from a number of different areas, such as the nose, intestinal tract, or uterus, or it may be at first entirely from a single source. There are, however, nearly always some petechiæ or ecchymoses in the skin, which point to the condition being a general rather than a local one. In some cases bleeding may persist, whatever is done, and the patient may die within a week of anæmia and exhaustion, or a cerebral hæmorrhage may prove fatal. More often, however, the bleeding ceases and within a few weeks the patient is restored to comparatively good health. Recurrences of hæmorrhage, however, are common.

Chronic forms of purpura hæmorrhagica, which often start in childhood, are more frequently encountered. Purpura is recurrent or persistent and hæmorrhage occurs from the mucous membranes, but it is usually not so severe as in the acute forms and the patient is less anæmic. In chronic types the spleen is often palpable, whereas in the acute type there is seldom any enlargement.

In all forms of purpura hæmorrhagica the platelet count is low when the patient is having symptoms, but during remissions it may reach a normal figure (250,000 to 400,000 per c.mm.). When the platelets fall below 40,000, hæmorrhage usually occurs, and during severe bleeding the platelets may be almost completely absent. There is generally a slight leucocytosis, and nucleated red cells may be seen. The so-called "capillary resistance" test is positive when bleeding is likely to occur. The tourniquet of a blood-pressure apparatus is put around the arm and blown up to midway between the diastolic and the systolic pressures for five minutes. The cuff is then removed, and if the test is positive, numerous purpuric spots appear below the level of the tourniquet. If blood is drawn from a patient with active purpura hæmorrhagica the retraction of the clot is delayed, though there is no prolongation of clotting time.

Differential Diagnosis.—Acute purpura hæmorrhagica can be readily distinguished from acute leukæmia by the presence of myelocytes and myeloblasts in the latter disease; in leukæmia, as in purpura hæmorrhagica, the platelets may be very much reduced. It is important to remember that some-

times purpura may be almost or completely absent, and if the bleeding is always from one organ such as the intestine, there is a risk of the general nature of the disease being overlooked. In such cases the platelet count is of great value. The symptomatic purpuras are usually readily distinguished if the patient is thoroughly examined.

Treatment—In many of the milder cases rest in bed abolishes the symptoms, and in the chronic forms of the disease, as the patient gets older the condition abates. No drugs (including liver) are of any value, though iron may aid convalescence when hæmorrhage has ceased. In chronic types splenectomy often produces remarkably successful results, and provided the patient is not seriously anæmic at the time of operation the mortality is low. In the acute forms of the disease with severe hæmorrhage the mortality of splenectomy is very high, and before contemplating operation the effect of a series of small transfusions (10 oz. at a time) should be tried. Hæmorrhage sometimes seems to cease following transfusion. The platelet count rises immediately after transfusion, and later usually falls again to below normal, but immediate recurrence of symptoms is unusual. Splenectomy should only be advised when the diagnosis of purpura hæmorrhagica has been confirmed by recurrent hæmorrhage, a low platelet count, prolonged bleeding time and a normal coagulation time, and a positive capillary resistance test. Operation is inadvisable, except as a desperate measure, when the patient is bleeding profusely and severely anæmic. In such cases several transfusions should be given before splenectomy.

HEREDITARY HÆMORRHAGIC STATES

1 **Hæmophilia**—This remarkable hereditary disease is confined to males, but is transmitted by the female, who, however, shows no manifestations of it herself. Family records show the persistence of the condition over periods as long as two hundred years. The clotting time of the blood is unduly long. This is probably due to increased stability of the platelets, whereby they do not disintegrate and liberate the thrombo-kinase required for the activation of prothrombin. The bleeding time in hæmophilia is normal.

Symptoms of the disease commence in infancy and are usually most severe before puberty, in those who survive to adult life the tendency to hæmorrhage appears to diminish. Bleeding may occur into the skin in the form of ecchymoses, as the result of minor degrees of trauma which would not

affect a normal person. Hæmorrhage from the mucous membranes particularly from the nose and gums, is common. Small cuts on the skin may bleed steadily for hours as the result of capillary oozing, and even minor operations such as the extraction of teeth may be fatal. When bleeding is prolonged severe anemia may develop, but the blood-forming organs appear to have great powers of blood regeneration. Occasionally hæmorrhages occur into joints, which become swollen and painful. Complete recovery of function may result after aspiration or absorption of the effused blood, but in course of time a crippling osteoarthritis may result.

Various measures have been tried for stopping bleeding, if the site is readily accessible, firm and prolonged pressure may be effective. Adrenalin or snake venom may be applied locally, and direct applications and injections of normal horse serum are recommended. Blood transfusion helps to promote coagulation as well as to restore hæmoglobin to the circulation, and is essential immediately before even the smallest surgical procedure. Trauma must be avoided at all costs and operations or tooth extraction performed only when absolutely necessary. Females from a hæmophilic family should not bear children. Liver feeding is useless, but beneficial results have been claimed for administration of ovarian extracts such as theelin, and extracts of egg white.

2 **Hereditary Telangiectasia**—This is a rare condition in which minute telangiectases or angiomas are found on the skin and mucous membranes, particularly in the nose. The cutaneous telangiectases are innocuous, but those in the nose or alimentary canal may bleed severely and produce severe anemia. The condition is hereditary and familial, affecting both sexes. Iron and transfusions are the only treatment available.

3 **Hereditary Purpura Hæmorrhagica**—In certain families there is a tendency to hæmorrhage, as shown by epistaxis or purpura. The coagulation time is not lengthened but the platelets are generally low and the disease resembles thrombocytopenic purpura. Splenectomy is of no value, and if severe hæmorrhage occurs transfusion may be necessary.

ANAPHYLACTOID PURPURA

This type of purpura includes Henoch's purpura and Schönlein's disease. There is neither deficiency of platelets nor lengthening of the coagulation time. The walls of the capillaries

are unduly permeable and allow blood cells and plasma to pass out into the tissues

In Schönlein's disease purpuric spots, urticarial wheals, or angioneurotic swellings appear on the skin, and joints may be swollen and tender. There is often slight pyrexia and a sore throat. The condition was formerly thought to be akin to acute rheumatism and was known as *peliosis* or *purpura rheumatica*. Spontaneous recovery takes place and there is no specific treatment.

In Henoch's purpura the main symptoms are attacks of severe abdominal pain, vomiting and diarrhoea. Blood may be passed by the bowel. Swelling of joints, purpura, and urticaria occur, but are a less prominent feature than in Schönlein's disease. The abdominal symptoms are due to exudation of plasma and blood into the wall of the intestine. Rarely this may produce an intussusception. Treatment is symptomatic only, and on no account should splenectomy be performed. Anaphylactoid purpura occurs mainly in children and during early adult life.

LEUKÆMIA

Under the general heading of leukæmia are included a number of clinical conditions in which the white cells are abnormal both quantitatively and qualitatively. While the various forms of leukæmia differ widely in their symptoms and course they resemble one another in that they are eventually uniformly fatal.

The leukæmias are classified into acute and chronic varieties and also according to the type of leucocyte chiefly involved. The acute leukæmias comprise acute myelogenous and acute lymphatic, according as the neutrophils or the lymphocytes are at fault. The chronic types consist of chronic myelogenous (often termed spleno medullary) leukæmia which is very occasionally eosinophilic, and chronic lymphatic leukæmia. In addition there are rare forms of leukæmia known as aleukæmic leukæmia, chloroma, monocytic leukæmia and leucerythroblastic anæmia. The acute leukæmias are difficult to distinguish on clinical grounds and may be described together.

Nothing is known of the ætiology of the leukæmias. By some they are regarded as new growths of the bone marrow, by others as a reaction of the marrow to infection. Occasionally acute leukæmia has followed injuries of bones or osteomyelitis. Heredity does not appear to play any part.

Acute Leukæmia—The main clinical features of the acute leukæmias are a rapidly fatal illness, pyrexia, a liability to early and severe hæmorrhage, ulcerative and necrotic lesions in the mouth and a severe and rapidly progressive anæmia usually of a microcytic type. Primitive red cells of all types, particularly normoblasts and reticulocytes, are frequently present. The spleen and lymphatic glands are seldom much enlarged and often impalpable. The blood picture varies with the acuteness of the disease and the type of white cell mainly implicated. The total leucocyte count is rarely over 30 000 until shortly before death when it may rise suddenly to 100 000. Acute myelogenous leukæmia is the type most commonly encountered in this disease; practically all the circulating white cells are myeloblasts. By ordinary staining methods the myeloblasts are non-granular and may be confused with large lymphocytes, but they may be shown to be primitive forms of granular cells if stained by the peroxidase method which stains the granules in the cytoplasm of all but the most immature cells of the granular series. In acute lymphatic leukæmia, which is excessively rare, the lymphocytes and lymphoblasts account for over 90 per cent. of the total white count.

The onset of acute leukæmia is usually abrupt and resembles that of any acute pyrexial illness. Very rarely the white cells may at first show no very definite abnormalities. In some cases severe ulceration and necrosis of the gums, tonsils and pharynx are striking features. In others hæmorrhagic symptoms predominate, such as epistaxis, uterine hæmorrhage, purpura, hæmorrhage into the brain or retina or from the intestinal or urinary tract. The hæmoglobin rapidly falls to about 20 per cent. and the colour index is usually low. Occasionally lymphoid deposits are found in the skin. Patients with acute leukæmia seldom survive for more than a few months, and in the more acute varieties death may occur within a fortnight.

Chronic Myelogenous Leukæmia—The onset is extremely insidious and often the first symptom is a sensation of dragging or weight in the left side of the abdomen due to an enormously enlarged spleen. The patient may also complain of lassitude and general ill health. Sometimes a retinal hæmorrhage may lead to the discovery of the condition. Blood examination in the early stages may show counts up to several hundred thousand leucocytes per cubic millimetre, but the hæmoglobin percentage and the number of red cells are often but little reduced. A typical differential count in a relatively early case shows the following percentages: neutrophils 70 per

cent, eosinophils, 2 per cent, basophils, 3 per cent, myeloblasts, 2 per cent, myelocytes, 18 per cent, lymphocytes 4 per cent, hyalines, 1 per cent. Basophil leucocytes are usually rather numerous, and this increase may call attention to the abnormal blood picture in any early cases. Normoblasts often occur and increase in number as the leukaemia progresses. On physical examination the spleen is enormously enlarged and may extend down to the left iliac fossa, and its sharp edge with well marked notches extends beyond the umbilicus. No glands are palpable, and the liver is usually not enlarged.

In the course of months, or even years, anaemia of a hypochromic type develops and the general health becomes increasingly impaired. The blood picture gradually changes to that of acute myelogenous leukaemia, and the percentage of myeloblasts steadily increases. At this stage there may be hæmorrhage from mucous membranes. Ultimately death occurs from exhaustion or intercurrent infection. Pyrexia is absent until severe anaemia develops. In a very rare form of the disease all the immature cells are found to be eosinophilic (eosinophilic leukaemia).

Chronic Lymphatic Leukaemia—This type is relatively rare and usually occurs in males above the age of fifty. The onset is gradual, and the most striking clinical features are a generalised enlargement of the lymphatic glands, which are discrete and painless. The spleen is easily palpable but does not reach the enormous size attained in myelogenous leukaemia. The liver is often enlarged. The total white count is rarely over 100,000 and at least 90 per cent of the cells are small lymphocytes with occasional lymphoblasts. Gradually a microcytic anaemia develops. Sometimes after a number of years an acute leukaemia may occur, or the patients die of exhaustion or from secondary infection.

Aleukæmic Leukaemia—Rarely in leukaemia the total number of white cells may remain low, but a differential count shows a high proportion of immature forms, i.e., myeloblasts, myelocytes, or lymphoblasts. Sometimes the total white count may even be under 1,000. Most of the patients of this type ultimately develop obvious leukaemia, the white count rising considerably shortly before the end.

Chloroma.—In this very rare condition nodular growths of lymphoid tissue are formed under the periosteum, especially in the orbit, skull, long bones, and sternum. The blood count is that of an acute leukaemia. Death occurs early, and a section of the chloromatous tumours shows a green colour which rapidly fades on exposure to air.

Monocytic Leukæmia—This condition is rare and tends to occur in middle life. It is frequently associated with ulcerative conditions in the mouth and pharynx, and is usually fatal within a few months. In it the total white count is as a rule less than 50,000, and 50 to 90 per cent of the white cells are monocytes.

Leuco-erythroblastic (osteosclerotic) Anæmia.—Cases have been described in which the clinical features and blood counts resemble those of a pernicious anæmia. There is, however, no improvement with liver treatment, and sooner or later myeloblasts and myelocytes appear and the patient presents the features of an acute leukæmia.

Differential Diagnosis of the Leukæmias.—Careful examination of even a single blood film usually provides sufficient evidence for a diagnosis of leukæmia, and in the case of the acute forms of the disease it is often difficult, if not impossible, to arrive at a correct diagnosis without the aid of a microscope. Failure to diagnose acute leukæmia is almost invariably due to lack of this elementary precaution. In every case of purpura or hæmorrhagic manifestations, unexplained severe anæmia, continued fever or ulcerative stomatitis, the suspicion of leukæmia must be borne in mind and a careful blood examination made. In the acute leukæmias, especially when hæmorrhage is occurring, the platelets are diminished in number as in purpura hæmorrhagica. A differential leucocyte count, however, will usually settle the diagnosis between leukæmia and purpura. Leuco-erythroblastic anæmia may at first be mistaken for pernicious anæmia, but the failure of the disease to react to liver treatment and the appearance of myelocytes and myeloblasts eventually indicate the correct diagnosis. Aleukæmic leukæmia may simulate agranulocytic angina, but here again the character of the leucocytes is diagnostic. Direct examination of stained bone marrow films obtained by sternal puncture may also be helpful in differential diagnosis.

With the chronic forms of leukæmia there is rarely any difficulty in diagnosis. In the myelogenous form the disease can often be diagnosed with fair certainty on clinical grounds alone, and a blood examination will settle any confusion with splenic anæmia or acholic jaundice. Chronic lymphatic leukæmia may be mistaken for Hodgkin's disease, lympho-sarcoma, glandular tuberculosis, or glandular fever unless the blood is examined.

Prognosis and Treatment of the Leukæmias—As has already been stated, acute leukæmia in all its forms is rapidly

are usually increased out of proportion to the hæmoglobin percentage. The heart is often dilated. Occasionally patients with erythræmia ultimately develop leukæmia.

The disease is a chronic one, which may last for years, with exacerbations and remissions, and the patient may die of intercurrent infection or sometimes as the result of cerebral hæmorrhage or thrombosis. Large hæmorrhages may occur from the alimentary tract, nose, or elsewhere, rendering the patient anæmic. Some patients show a tendency to intra-vascular clotting with its resultant sequelæ, such as coronary thrombosis. Repeated venesections help to relieve the symptoms, and X-ray applications to the long bones are often successful. The oral administration of phenylhydrazine hydrochloride reduces the red cell count by increasing the tendency to hæmolysis, but it must be given with caution as the effect may be prolonged and the fall in the red count continuo after administration of the drug has ceased. The drug is given by mouth in daily doses of 2 gr for seven to ten days, but its use must be carefully controlled by blood counts.

METHÆMOGLOBINÆMIA AND SULPHÆMOGLOBINÆMIA

In these conditions the most striking clinical feature is cyanosis, affecting chiefly the lips, mucous membrane of the mouth and the nail beds, unaccompanied by any respiratory embarrassment. The cyanosis is due to the formation of methæmoglobin or sulphæmoglobin in the blood. In the great majority of cases the cyanosis is due to sulphæmoglobin, and occurs as a result of repeated ingestion of certain aniline dye derivatives, such as acetanilide or phenacetin, these drugs are often present in "headache" remedies. At the present time drugs of the sulphonamide type are the most frequent cause of the condition (*vide p 71*). Probably other factors apart from such drugs may play a part in the production of cyanosis. Most of the recorded cases of sulphæmoglobinæmia give a history of severe and chronic constipation, and it is probable that hydrogen sulphide formed in the colon may, under the influence of the aniline derivatives, unite with hæmoglobin to form sulphæmoglobin. In addition to constipation there is often a history of frequent headaches and some degree of mental instability, the headache being generally the reason for the drug habit. Methæmoglobinæmia is a rarer condition, and occurs as an acute poisoning following a massive dose of an aniline derivative, either ingested or absorbed.

through the skin. The condition has also been described in a few patients in whom there appeared to be no evidence of drug addiction.

The disease is readily diagnosed by the discovery of the absorption bands of methæmoglobin or sulphæmoglobin in the blood spectrum. Clinically it may be suspected when cyanosis particularly affecting the lips and fingers, occurs without any history or evidence of shortness of breath on exertion. With withdrawal of the drug concerned the cyanosis rapidly disappears if it is due to methæmoglobin but much more slowly in cases of sulphæmoglobin. No special treatment is usually required beyond keeping the bowels open. Sulphates must not be given for this purpose.

HÆMOGLOBINÆMIA AND HÆMOGLOBINURIA

In normal blood hæmoglobin is present in the corpuscles only, but in a variety of pathological conditions it is found also in the plasma owing to disintegration of red corpuscles. When this occurs to any considerable extent hæmoglobin is excreted in the urine and the patient is said to be suffering from hæmoglobinuria. The occurrence of the latter symptom always implies the existence of hæmoglobinæmia or free hæmoglobin in the plasma.

Hæmoglobinæmia occurs in the following conditions: (1) following blood transfusion if the serum of the recipient hæmolyses the donor's corpuscles, (2) in blackwater fever (*vide p. 176*), (3) in poisoning by certain drugs notably potassium chlorate and arseniuretted hydrogen, (4) in severe burns. In addition to the above, hæmoglobinæmia and hæmoglobinuria occur as transient but recurring phenomena in certain individuals, who are then said to suffer from paroxysmal hæmoglobinuria.

Paroxysmal Hæmoglobinuria—The paroxysms are initiated by exposure to cold. During attacks there may be general symptoms such as lassitude, vomiting, and slight pyrexia. The urine becomes dark in colour, and on spectroscopic examination shows the absorption bands of hæmoglobin and often of methæmoglobin, but no red corpuscles can be seen with the microscope. Attacks last from a few hours to a day and are seldom dangerous to life, but occasionally the deposition of hæmoglobin in the renal tubules leads to anuria and uræmia.

If the finger of a patient liable to hæmoglobinuria is placed in iced water with its circulation stopped by a tourniquet,

within a few minutes hæmoglobinæmia occurs, and blood taken from the finger contains free hæmoglobin in the plasma. Also, if the serum of the patient be mixed with normal red corpuscles and cooled, the latter become laked. Both these experiments indicate that cold is the precipitating factor in the production of hæmoglobinæmia. The almost constant finding of a positive Wassermann test in the blood of persons with paroxysmal hæmoglobinuria suggests that in some way syphilis may produce a hæmolysis in the blood.

Treatment—Obviously, avoidance of cold is of primary importance in the prophylaxis of paroxysms. During the attacks plenty of fluids must be taken in order to avoid concentration of the urine. Unfortunately, anti-syphilitic treatment is usually ineffective in preventing hæmoglobinuria.

HODGKIN'S DISEASE (*Lymphadenoma*)

Practically nothing of importance has been added to our knowledge of Hodgkin's disease since it was first described by Hodgkin over a hundred years ago.

Ætiology—Hodgkin's disease occurs more frequently in males than in females, and it is particularly prone to attack its victims during adolescence or early adult life. Nothing is known as to the circumstances favouring the development of the disease, which occurs with equal frequency among rich and poor, and no country or climate seems exempt.

Symptoms—The onset of the disease is usually gradual and the first symptom noticed is an enlargement of some group of glands, most frequently in the neck. Later, as the disease progresses other groups of lymph glands become involved, the patient loses weight, becomes anæmic, and sometimes suffers from the effects of pressure of the glands on neighbouring structures. The symptoms referable to various organs are described separately below.

1. *Lymphatic Glands*—The typical glands of Hodgkin's disease are enlarged and discrete, with no tendency to adhere either to the skin or to the deeper structures, on palpation they feel elastic, but in the later stages become harder. They are neither painful nor tender. Eventually most of the lymph glands in the body become affected, but at the onset the most common site for glandular enlargement is the posterior triangle of the neck on one or other side. As a result of X-ray treatment or secondary infection of the glands, adhesions to the skin very

occasionally occur, but in any early case the finding of a gland which is definitely adherent contraindicates a diagnosis of Hodgkin's disease

2 *Spleen*—This is enlarged in about 50 per cent of cases. It seldom extends more than 2 in below the costal margin and is not tender

3 *Cutaneous Manifestations*—Pruritus is sometimes an early symptom. It may continue throughout and prove a formidable problem in treatment. More rarely there are small deposits of lymphadenomatous tissue in the skin

4 *Lungs*—Enlarged mediastinal glands may compress the lung. Pleural effusions occur in the later stages, due either to pressure on veins or to direct involvement of the pleura

5 *Blood*—There is nothing typical about the blood picture in Hodgkin's disease. Sooner or later a severe anaemia develops. Eosinophilia (above 10 per cent) is found in about 10 per cent of cases

6 *Pyrexia*—Nearly all patients with Hodgkin's disease are febrile at some time during its course. The fever is often low and irregular, and resembles that seen in pernicious anaemia and other blood diseases. Sometimes periods of pyrexia lasting five to ten days occur, with apyrexial intervals between the attacks. Pyrexia of this type often occurring without obvious enlargement of external glands is known as the *Pel-Ebstein Syndrome*. In such cases there is an enlargement of the mediastinal glands

7 *Nervous System*—Pressure of enlarged glands upon nerves often gives rise to pain. In rare cases a paraplegia develops as the result of pressure on the cord

Pathology.—The cause of Hodgkin's disease remains undiscovered. Gordon has been able to produce an encephalitis in rabbits by intracerebral injection of lymphadenomatous glands, and it has been suggested that the disease is due to an unknown virus. It certainly is not due to tuberculous infection, although the latter may sometimes be present as a complication. Nor is there any evidence that it is in the nature of a malignant growth except its invariably fatal issue

At autopsy the lymphatic glands are found to be enlarged, white, and homogeneous. The amount of fibrous tissue varies with the chronicity of the condition. Suppuration or caseation is rare, except when in the heart by tuberculosis. Microscopically the tissue is characterized by the presence of endothe-
lial cells and

If the finger of a patient liable to hæmophilic features is immersed in iced water with its circulation stopped 10 or more nuclei

and numerous eosinophil leucocytes. The spleen is moderately enlarged, and on section shows greyish white areas about the size of peas which, under the microscope, show similar changes to those found in the lymph glands. These small deposits are scattered throughout the spleen, which is usually described as "hard hake." Similar deposits occur in other organs, particularly in the liver and intestinal tract.

Diagnosis—Although typical cases of Hodgkin's disease can be diagnosed on clinical grounds, it is often impossible to be certain of the diagnosis without excising a gland. Sometimes even the histological examination of a gland may leave the diagnosis in doubt, and in such cases the production of encephalitis in a rabbit injected with the suspected gland may be of value in diagnosis. The resemblance between the glandular enlargement of Hodgkin's disease and that due to tuberculosis is so close that mistakes are very common, unless a gland be removed for section. Examination of a blood film will readily exclude lymphatic leukaemia, while the enlarged glands in syphilis are usually smaller, harder, and more shotty to the touch than in Hodgkin's disease, and the epitrochlear glands are seldom enlarged in the latter disease. Glandular enlargements in the neck due to septic teeth or infections of the scalp may be mistaken for Hodgkin's disease. Malignant glands in the neck are usually localised and extremely hard. In lymphosarcoma the glands tend to produce pressure symptoms earlier than in Hodgkin's disease, but in cases of doubt removal and section of a gland will determine the diagnosis. Lastly, glandular fever may produce a generalised glandular enlargement, but in this disease there is tenderness on palpation of the glands, a relative monocytosis in the blood and the heterophile antibody reaction will be positive.

In some cases of Hodgkin's disease where the superficial lymphatic glands do not become enlarged until late in the disease, the severe anaemia which sometimes develops may suggest pernicious or other form of anaemia. A pyrexia without obvious cause, particularly if it assumes the typical Pel-Ebstein type, should always arouse a suspicion of Hodgkin's disease in the mediastinal or retroperitoneal glands. An X-ray of the chest may demonstrate the presence of masses in the mediastinum.

Treatment—Unfortunately there is no specific treatment for Hodgkin's disease. Although temporary improvements may occur from time to time, the disease pursues a relentless downhill course, until death occurs as the result of anaemia and exhaustion or from the pressure effects of the enlarged glands.

on vital organs. In the early stages deep X ray therapy and radium usually produce a rapid diminution in the size of the glands, but unfortunately relapse always occurs and further radiation treatment is usually ineffective. Attempts to remove the affected glands by surgical means are always futile. The only drug that appears to have any beneficial action is arsenic taken in large doses. With severe pruritus veronal in 10 gr doses may be effective.

LYMPHO SARCOMA

Sarcomatous growths may originate in lymphoid tissue in any part of the body, but most commonly in the lymphatic glands. The cervical glands are frequently involved, as are also those situated in the chest and abdomen. The symptoms depend mainly on the site of the glandular enlargement and on pressure effects on surrounding parts. With involvement of the mediastinal glands obstruction of the superior vena cava is likely to occur, and results in venous congestion of the upper part of the body.

Glands affected by lympho-sarcoma are at first painless and may remain unattached to the skin and surrounding structures. Sooner or later, however, these will become involved by the growth. Often several groups of glands may be enlarged simultaneously, and the clinical condition closely resembles Hodgkin's disease. In order to arrive at a definite diagnosis it may be necessary to remove a gland for microscopic examination.

If the lympho sarcomatous glands are localised they should be excised, but when disseminated or very adherent they can often be rapidly reduced in size by deep X ray therapy. Even after apparently complete removal a course of X ray treatment is advisable. The outlook is always bad, particularly in cases with involvement of mediastinal glands.

GLANDULAR FEVER

This disease is characterised by fever, enlargement of lymphatic glands, and an increase in the leucocyte count with a preponderance of monocytes and large lymphocytes. It occurs in small epidemics, often in schools and is sometimes known as *infective mononucleosis*. The prevalence of the disease varies considerably from year to year. Nothing is known

of its causation, but it is certainly due to some infective agent

Symptoms—These vary in different epidemics and at different ages. In small children there is often a sore throat at the onset and the cervical glands become enlarged and tender. The neck is stiff and painful to move. Enlargement of other groups of glands may occur but is less striking in extent than that of the cervical glands. The temperature varies from 100° to 103° . Enlargement of mediastinal or mesenteric glands may lead to paroxysmal cough and vomiting respectively. The spleen is often palpable.

In adults there is rarely a sore throat, and glandular enlargement is a less striking feature than is the case in childhood. After about a week there is often a maculopapular rash, which rather resembles that of typhoid fever or if profuse, rubella. In children rashes are unusual.

Both in adults and children there is a leucocytosis usually between 15,000 and 20,000, and the differential count shows a striking increase in the mononuclear cells, which may form over 90 per cent of the total. This mononucleosis is sometimes ovanescent, but it often persists for many months.

After a course varying from a week to several months convalescence is established. Serious complications and death are very rare.

Diagnosis—Except in the presence of an epidemic a diagnosis of glandular fever should not be made until more serious possibilities have been excluded. Among these is lymphatic leukaemia which, especially in its aplastic form, may at first simulate glandular fever. The development of severe anaemia and the downhill course will usually render the true diagnosis clear. Other possibilities which must be borne in mind are tuberculous adenitis, secondary syphilis, septic adenitis, and Hodgkin's disease. Important points in favour of a diagnosis of glandular fever are (1) tenderness of the glands, (2) mononucleosis, (3) the absence of anaemia.

A diagnostic laboratory test is available because the serum of patients with glandular fever shows an increase in agglutinin content for sheep's red cells, if a series of dilutions of serum is tested against a constant sheep cell suspension, the agglutinin titre is usually found to be far higher than normal. This is known as the heterophile antibody reaction (Paul and Bunnell).

Treatment—Symptomatic treatment only is available, such as warm applications to the glands, plenty of fluids, and perhaps an alkaline mixture.

DISEASES OF THE SPLEEN

Complete removal of the spleen is not incompatible with perfect health, and its physiological functions can undoubtedly be taken on by other organs. In adult life the spleen, as part of the reticulo-endothelial system, plays an important part in the destruction of red blood corpuscles and in the metabolism of iron. It also acts as a storehouse for a surplus supply of red corpuscles which can be readily mobilised into the general circulation when required, as, for instance, after severe hæmorrhage. It may also be concerned in the formation of antihodies as a reaction to infection.

Splenic Enlargement—Thus may occur in a variety of morbid conditions: (1) in acute infective conditions, *eg*, typhoid fever, septicæmia, subacute bacterial endocarditis, (2) in chronic infections, *eg*, tuberculosis, congenital syphilis, possibly Hodgkin's disease, glandular fever, (3) in protozoal infections, *eg*, malaria, kala azar, (4) in diseases of the blood and blood-forming organs, *eg*, pernicious anæmia, the leukæmias, acholuric jaundice, polycythæmia, and splenic anæmia, (5) in conditions where there is interference with the circulatory system of the spleen, *eg*, thrombosis of the splenic vein, cirrhosis of the liver, or splenic infarction, (6) in conditions in which the spleen appears to store abnormal metabolites, *eg*, amyloid disease, (7) in very rare instances of neoplastic secondary deposits, *eg*, melanotic sarcoma.

In most of the diseases classified above, splenic enlargement is but one, and often not the most prominent feature, but in the group of splenic enlargements known as splenic anæmia it is possible that the spleen is the primary seat of disease.

To palpate for an enlarged spleen the examiner should stand on the right hand side of the recumbent patient and place his right hand flat upon the abdomen with the fingers near the left costal margin. With the left hand the left lower ribs are pressed firmly forwards, and the patient is instructed to take a deep slow breath. If the spleen is enlarged it will be felt to descend from under the costal margin against the examining fingers. The *characteristic features of a splenic tumour* are: (1) a sharp lower edge in which sometimes a notch is palpable, (2) the tumour is superficial, dull upon percussion and the hand cannot get above the tumour, (3) unless very large, it does not extend into the loin. The direction of enlargement is downwards and inwards towards the umbilicus, and the

tumour is found to move on respiration. With great enlargement there may be visible bulging in the left hypochondrium. In acute infections the spleen is often tender and rather soft, but unless it is possible to feel a sharp lower margin it is dangerous to diagnose splenic enlargement.

SPLENIC ANÆMIA

It is uncertain whether so called splenic anæmia has any separate clinical entity. Probably many of the cases thus diagnosed were in reality instances of cirrhosis of various types with enlarged spleens, acholic jaundice, chronic types of purpura, Gaucher's splenomegaly, or even leukaemia. Certainly as knowledge of blood diseases has increased, splenic anæmia has become a less frequent diagnosis.

The relationship between splenic anæmia and the condition of splenomegaly and cirrhosis of the liver, described in Italy by Banti and known by his name, has been a matter of dispute. It is often maintained that Banti's disease represents a late stage in splenic anæmia. There is, however, little evidence in support of this assumption, though cirrhosis of the liver is often accompanied by more or less splenic enlargement. Many cases of splenic anæmia run their course without evidence of cirrhosis, and cases corresponding to Banti's description of his disease are rare, if not unknown, in England.

Ætiology and Pathology—As it is uncertain whether splenic anæmia is a clinical or pathological entity as might be expected, nothing is known of its ætiology and pathology. There is no evidence of hemolysis and no constant pathological findings. When hæmatemesis occurs it is presumably due to rupture of œsophageal varices as in cirrhosis.

Symptoms—The onset of the disease is insidious, though occasionally hæmatemesis may be the first symptom to call attention to the condition. The spleen is much enlarged, hard, and often reaches the umbilicus or beyond. Anæmia of a *microcytic type with a low colour index and a leucopenia* is usually present, quite apart from severe hæmatemesis, though when this occurs it naturally aggravates the anæmia. Hæmatemesis is the most important and dangerous symptom, and may be both profuse and recurring. After the disease has lasted for some years there is sometimes evidence of the onset of cirrhosis of the liver. At first this organ may be enlarged, but eventually it tends to diminish in size, while jaundice, ascites, and emaciation develop. The patient usually suffers from the symptoms common to all anæmias, such as

breathlessness, pallor, palpitation and lassitude. As in other anæmias a hæmic murmur is often present over the base of the heart. Often the weight of the enlarged spleen produces dragging pains in the abdomen. Occasionally purpuric spots are seen on the skin.

Course and Prognosis—The disease is a very chronic one and occasionally may last twenty years or more. Spontaneous recovery may occur, but more often the condition slowly progresses until it terminates in death from intercurrent infections hæmatemesis or cirrhosis.

Differential Diagnosis—The occurrence of splenomegaly in several members of a family suggests Gaucher's splenomegaly or acholuric jaundice. If splenomegaly be associated with purpura or recurrent hæmorrhage from the nose, gums or else where purpura hæmorrhagica is a possibility. The leucocyte count will be characteristic in leukaemia.

Treatment—Splenectomy is often advised in cases diagnosed as splenic anæmia. The results of the operation are often disappointing and do not compare with those of splenectomy in acholuric jaundice or thrombocytopenic purpura. Moreover the mortality is considerable. Large doses of iron are often beneficial and transfusion may be required especially if the patient has had severe hæmatemesis.

Gaucher's Splenomegaly—This disease was formerly considered to be identical with splenic anæmia. It differs from the latter in being frequently familial though not hereditary. The spleen is enormously enlarged but the anæmia is seldom as severe as in splenic anæmia. Hæmatemesis very rarely occurs but slight epistaxis and bleeding from the gums is common. The liver is very large throughout the disease but cirrhosis does not occur. In spite of the great enlargement of spleen and liver the disease is compatible with relatively good health for many years. The spleen, liver, lymph glands and bone marrow are packed with characteristic large 'foamy' lipid cells of an endothelial type. In view of the relatively mild symptoms splenectomy is not advisable.

J. J. CONYBEARE
F. A. KNOTT

DISEASES OF THE ALIMENTARY CANAL

GENERAL CONSIDERATIONS

BOTH in hospital and private practice very large numbers of patients are encountered whose main symptoms are rightly or wrongly referred to the abdomen. In consequence, one of the most frequent and yet most difficult problems which face the medical attendant is to decide to what extent the internal organs of digestion are affected by disease. It is important to realise that of the many patients who complain of "indigestion" only a relatively small proportion suffer from organic lesions such as a peptic ulcer. Often the symptoms referred by the patient to his abdominal viscera are in reality but reflex expressions of diseases elsewhere or an indication of a failure on the part of the patient to adjust himself satisfactorily to his environment.

Although "nervous indigestion" is extremely common, it is most important, both from the point of view of the patient and of the doctor, that such patients should not be labelled as neurotics until a thorough examination and investigation has so far as possible excluded the presence of an organic lesion. We must all of us be familiar with those unfortunate individuals in whom a failure on the part of the doctor to diagnose organic disease in its earlier stages has allowed it to progress to a condition in which cure is difficult or impossible.

In cases of suspected abdominal disease a careful history is of the utmost importance. The patient should be allowed to tell his own story. Particular attention should be devoted to the duration of his symptoms, the occurrence of remissions, the nature of his pain and its relationship to meals, the presence of constipation or diarrhoea. Apart from the actual information obtained in taking a careful history, the contact which it establishes between doctor and patient is of great value in enabling the physician to gain an insight into the mental attitude of the patient and his degree of sensibility to pain, points which are of great value in diagnosis.

A thorough physical examination of all the systems of the body must never be omitted. Not infrequently this may reveal some unsuspected lesion, to which the abdominal symptoms are purely secondary. Thus, for example, the earliest symptoms of phthisis may be dyspepsia, or attacks of abdominal pain or vomiting may be due to *tuberculosis dorsalis*, lead poisoning, or uræmia.

Before attempting to examine the abdomen, attention must be paid to the following points: (1) The patient should lie comfortably on his back with his head slightly raised and supported on a pillow, (2) the abdomen must be well and evenly illuminated, (3) the hands of the examiner must be thoroughly warm. Neglect of any of these precautions will render efficient examination difficult or impossible.

It is well to carry out an abdominal examination in a routine manner beginning with *inspection* of the whole abdomen and lower part of the chest. Note should be made of the general appearance of the abdomen, whether distended or flattened and in the former case whether the distension is local or general. It is also easy to see whether there is any restriction of the normal abdominal respiratory movements. Lastly, it is important to look for visible peristalsis in the stomach or intestines. This may often be elicited by flicking the abdominal wall with a finger. In very thin subjects it is sometimes possible to see the peristaltic movements of normal small intestine, but as a rule visible peristalsis is of great significance, and indicates obstruction at some point in the alimentary canal. In such cases the peristaltic waves are repeated at intervals in the same locality and direction. During inspection the patient should be asked to point out exactly the point at which pain is felt.

Following inspection, the abdomen is examined by *palpation*. It is important to gain the patient's confidence by beginning with gentle palpation with the hand flat on the abdomen. If one side or area of the abdomen is the seat of pain, the examination should be commenced by palpating some other part. During palpation cultivate a flow of small talk to the patient with a view to distracting his attention from what is being done and never ask whether pressure at any particular point is painful. If a careful watch is kept on the patient's face, the tender points, if any, will be instantly revealed by his expression, without the possibility of suggestion on the part of the examiner. The extent and localisation of rigidity of the muscular wall should be noted, and an attempt made by diverting the patient's attention to abolish it. If the

rigidity is persistent, and especially if it is associated with local tenderness on pressure, it will usually indicate involvement of the peritoneum. During palpation, tumours may be detected, and an attempt should then be made to determine their mobility, more particularly with reference to respiratory movements. In addition to the central part of the abdomen, the flanks must be palpated bimanually, while doing so the examiner should be on the same side of the patient as the flank to be examined, and should place one hand behind, immediately below the ribs, while the other presses on the front of the abdomen, the patient is instructed to take deep breaths, and during inspiration tumours in the loin, such as an enlarged or unduly mobile kidney, may be felt to descend and may be gripped between the fingers. If the patient is cold palpation of the abdomen is rendered very difficult.

Percussion of the abdomen is, as a rule, of little value except for the detection of "shifting dullness" when there is free fluid in the peritoneal cavity. Auscultation of the abdomen is of value in the diagnosis of acute abdominal conditions as the peristaltic movements of the intestines may be audible, thus rendering a diagnosis of peritonitis unlikely. Rarely a friction rub may be heard over an inflamed organ, such as the spleen or liver.

Much stress used to be laid on the detection of areas of cutaneous hyperæsthesia, but these are usually if not always the result of suggestion on the part of the examiner. If the stomach is much dilated, a euecussion splash may be heard, when sudden pressure is exerted upon the epigastrium. This indicates delay in emptying, unless a meal has been taken within two hours of examination.

The importance of investigations such as X-ray examinations, test meals, and chemical examinations of the faeces cannot be overestimated. During the last fifteen years advances in radiological technique have greatly increased the value of opaque meals and enemata. Valuable though these aids to diagnosis may be, it is still true that they are an addition to, and not a substitute for, a carefully taken history and a thorough physical examination. Every patient with digestive symptoms, which fail to clear up within a reasonably short period, should be advised to undergo a thorough investigation to exclude serious organic disease. Such an investigation not infrequently may reveal the presence of an organic lesion which has been entirely unsuspected from a consideration of the history and the physical examination. Negative findings

The mouth is dry, and scattered over the tongue, gums, cheeks, and palate there are white patches, irregular in shape and slightly raised above the surrounding mucous membrane. In infants there may be difficulty in swallowing and also diarrhoea, with excoriation of the skin around the anus.

The mouth should be kept clean with cotton wool soaked in the following mixture: potassium chlorate, gr. xxv, glycerinum boracis, ad 3i, and the patches painted with 1 per cent gentian violet solution. With this treatment and attention to the general health, recovery is usually rapid.

Ulcerative Stomatitis—Widespread ulceration may occur in the mouth as the result of infection with the spirochaetae and fusiform bacilli which are found in Vincent's angina (*vide* p. 592). The condition occurs in epidemic form and may be associated with severe constitutional symptoms. The ulcers should be carefully painted with a mixture of equal parts of tinct. ipecac. and liq. arsenicalis. Improvement has been claimed as the result of giving nicotinic acid in doses of 100 to 200 mgm. daily.

Gangrenous Stomatitis (Cancerum Oris)—This dangerous condition affects small children and is specially prone to occur after measles. An ulcer appears on the cheek or gum and the surrounding tissues become black and gangrenous. Although the temperature is seldom high, death occurs rapidly from exhaustion or pulmonary infection. The gangrenous area should be excised early and the surrounding tissues cauterised.

Ludwig's Angina is an acute infection of the floor of the mouth, producing marked swelling under the jaw and in the neck. The condition develops rapidly, with severe constitutional symptoms. Treatment consists in early incision and drainage.

DISORDERS OF THE SALIVARY GLANDS

Ptyalism, or excessive secretion of saliva, most commonly is due to oral sepsis. It may also occur reflexly in trigeminal

Xerostomia, or deficient secretion of saliva, is usually present in the acute fevers, and leads to a dry and septic condition of the mouth and tongue. It may occur also in diabetes and severe diarrhoea, owing to the large amount of fluid lost in the urine and faeces. Atropine and belladonna also diminish the secretion of saliva.

Specific Parotitis, or Mumps (*vide* p. 35).

Septic Parotitis.—Infection of the parotids may occur in any condition in which the mouth is dry and septic as the result of prolonged illness, such as typhoid fever and cholera. If suppuration occurs, the glands need incision and drainage. The condition is often a terminal one.

Mikulicz's Disease.—This is a rare condition characterised by a chronic enlargement of the salivary and lachrymal glands. The glands are hard and painless, and the condition is usually symmetrical. The aetiology is uncertain. Potassium iodide or X-ray therapy are sometimes beneficial.

DISEASES OF THE ŒSOPHAGUS

Anatomy and Physiology.—The œsophagus extends from the termination of the pharynx at the lower border of the cricoid cartilage to the cardiac orifice of the stomach. Its average length in an adult is 10 in., but more important from the clinical point of view is the distance from the front teeth to the cardiac orifice, which is usually about 20 in. The relations of the œsophagus are important, as surrounding structures may be involved in disease of the organ, or, conversely, pathological conditions in the neighbourhood of the œsophagus may produce obstruction of its lumen.

From its commencement in the neck the œsophagus lies immediately behind and in close contact with the trachea, while the recurrent laryngeal nerves lie in the grooves between the two on either side. In the thorax the œsophagus passes through the superior and posterior mediastina, crossed by the left bronchus at the level of the fifth dorsal vertebra. The lumen of the œsophagus presents two well-defined constrictions, one at the level of the cricoid and the other at the point where it is crossed by the left bronchus; both of these are specially liable to be the site of a malignant growth. The arch of the

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DISORDERS OF THE SALIVARY GLANDS

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Treatment of ptyalism depends on the underlying condition, but belladonna or atropine may produce a symptomatic improvement. In ptyalism associated with anxiety neuroses a bromide mixture is of value.

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Unlike other parts of the alimentary canal the mucous membrane of the œsophagus is sensitive to thermal stimuli; if hot or cold fluids be drunk or passed into the œsophagus

through a rubber tube, a sensation of heat or cold is felt deep in the chest or epigastrium. The power of localising abnormal sensations is extraordinarily good, and the site of obstruction by a foreign body or growth can be indicated on his anterior chest wall by the patient with remarkable accuracy. At the point where the œsophagus enters the stomach is the cardiac sphincter, which is normally closed. Relaxation of the sphincter follows the swallowing reflex. Derangement of the neuromuscular control may prevent relaxation of the sphincter, resulting in a condition which will be described under the term achalasia of the cardia.

ŒSOPHAGITIS AND ŒSOPHAGEAL ULCER

Acute œsophagitis may follow swallowing of hot or corrosive fluids or the impaction of a foreign body. Chronic œsophagitis, often with superficial erosions of the mucous membrane, occurs in achalasia of the cardia (*vide p 389*). It may also be due to oral sepsis and alcoholism.

Peptic Ulceration of the Œsophagus occurs more frequently than it is recognised. It is sometimes due to the presence of heterotopic areas of gastric mucous membrane in the œsophagus, which secrete hydrochloric acid. The chief symptom is pain behind the lower end of the sternum which comes on immediately or shortly after food, particularly solid food, is swallowed. Owing to spasm of the cardia there may be some degree of dysphagia. Hæmorrhage occurs, which, though seldom severe, is sufficient to produce considerable occult blood in the faeces and may render the patient anæmic. Relief may be obtained by a purely fluid diet and alkalis. If dysphagia is troublesome atropine gr $\frac{1}{16}$ given hypodermically half an hour before a feed, or 5 gr of anæsthesin (Bayer) dissolved in 1 oz of olive oil, may relieve spasm and pain. If symptoms are intractable and severe, temporary gastrostomy may be required. X ray of the œsophagus in the erect position shows no ulcer, but a crater can often be demonstrated if an opaque emulsion is swallowed while the patient is lying down. Not infrequently an œsophageal ulcer complicates congenital diaphragmatic hernia (*vide p 415*).

ŒSOPHAGEAL OBSTRUCTION

Practically all the pathological conditions of the œsophagus which are commonly met with show as their most prominent symptom difficulty in swallowing, known as dysphagia. The

causes of œsophageal obstruction may be classified as follows —

- 1 Malignant stricture of the œsophagus
- 2 Non malignant stricture
 - (a) Impaction of a foreign body in the œsophagus
 - (b) Cicatricial stenosis following trauma
 - (c) Gumma (excessively rare)
 - (d) Peptic ulcer of the œsophagus
 - (e) Congenital stricture
 - (f) Diaphragmatic hernia
- 3 Derangement of the neuromuscular mechanism
 - (a) Achalasia of the cardia
 - (b) Plummer Vinson syndrome (*vide p 355*)
- 4 Pressure upon the œsophagus from without
 - (a) Goitre
 - (b) Aortic aneurysm and mediastinal tumours
 - (c) Diverticula of the œsophagus
- 5 Hysterical dysphagia

In addition to the above, dysphagia may result from pathological conditions in the mouth and pharynx, such as growths of the tongue, tonsillitis, or retropharyngeal abscess. Palatal and pharyngeal paralysis may produce dysphagia, as, for example, in diphtheria, bulbar palsy, or myasthenia gravis.

CARCINOMA OF THE ŒSOPHAGUS

This is the most frequent cause of dysphagia in patients over middle age. The onset is insidious, at first there is nothing beyond an occasional tendency for solid food "to stick in the throat." This symptom, after intermissions lasting many weeks, becomes more frequent, until it is found impossible to swallow solids. Later there is difficulty even with fluids, and ultimately nothing can be taken at all. Attempts to swallow result in regurgitation, but as a rule pain is strikingly absent, though occasionally pain in the chest may be an early symptom. Death occurs usually from inanition, or sometimes from secondary deposits or mediastinitis. Occasionally pressure on surrounding structures such as the recurrent laryngeal nerve produces a paralysis of the larynx with aphonia, which may occur before any dysphagia is noted.

Carcinoma of the œsophagus most commonly occurs in three situations: at the junction of the pharynx and œsophagus, at the point where the œsophagus is slightly narrowed by the

crossing of the left bronchus and at the cardiac orifice. As a rule the patient is able from his subjective sensations to localise fairly accurately the site of the obstruction.

Although it is usually easy to diagnose a growth of the œsophagus on clinical grounds in view of the age of the patient, the history of the gradual onset of the dysphagia, and the rapid emaciation, the diagnosis can be readily confirmed by further investigations. The most valuable of these is an X ray examination in which the patient is given a meal containing lumps of bread soaked in barm. If a fluid emulsion is used carcinoma in an early stage may easily be overlooked. The patient is examined erect in the left lateral position and the opaque meal is watched during its passage through the œsophagus. Irregularity in the lumen of the œsophagus and partial or complete obstruction are readily demonstrated. Incidentally, an X ray examination may reveal pathological conditions of other organs, such as an aortic aneurysm, which might produce dysphagia. An œsophageal growth may be localised by the passage of a mercury tube. This consists of a rubber tube about the thickness of a fore finger which is closed at both ends and contains mercury to increase its weight, the lower end being rounded. Owing to its weight and flexibility, the tube readily drops through the œsophagus into the stomach in the absence of an organic stricture. The growth can be viewed through an œsophagoscope, and a piece removed for histological section if required. On no account should a bougie be passed. Quite apart from the possible though improbable perforation of an aortic aneurysm there is a very grave risk of perforating the œsophageal wall immediately above the growth.

Occasionally a carcinoma of the stomach near the cardiac orifice may produce dysphagia as an early symptom. Such cases may be misdiagnosed as œsophageal growths but X ray examination and œsophagoscopy will settle the diagnosis. Early growths near the cardia have occasionally been removed successfully.

Unfortunately the treatment of carcinoma of the œsophagus is only palliative and death usually results within two years or less of the onset of symptoms. If the obstruction is severe a gastrostomy is sometimes performed, but life subsequently is usually a misery. More satisfactory results can usually be obtained by diathermy of the growth through an œsophagoscope. After this procedure the patient is often able to swallow comfortably for some months. Intensive deep X ray treatment or the implantation of radon seeds through an œsophagoscope

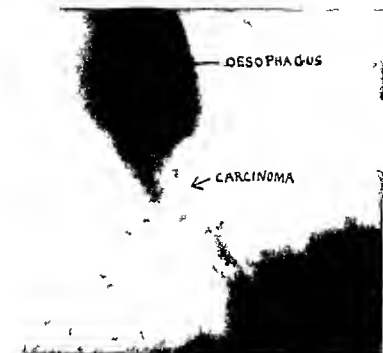


PLATE 14 —Carcinoma at Lower End of the Oesophagus
(From Plate by Dr P J Briggs)



PLATE 15 —Achalasia of the Cardia (From Plate by Dr P J Briggs)

may produce complete relief of symptoms. Unfortunately recurrence is almost certain. When the growth involves the middle of the oesophagus it is possible with an oesophagoscope to insert a Souttar's tube into the stricture. This consists of a flexible metal tube made of silver wire, which remains in position and prevents complete occlusion of the oesophagus.

Non-Malignant Stricture of the Oesophagus—This condition most commonly follows the swallowing of corrosive fluids either accidentally or with suicidal intent. The cicatricial stricture which develops is treated by dilatation. The patient swallows a silk thread, which passes through the stricture into the jejunum. A special metal dilator is threaded on the silk and with the latter acting as a guide, enters and dilates the stricture. Dilatation must be repeated at intervals. Strictures may also be dilated under direct vision through an oesophagoscope.

Obstruction of the oesophagus by a foreign body must be relieved at the earliest possible moment by removal through an oesophagoscope. No attempts at "blind" removal by corn catchers or similar implements should be made, as there is grave danger of perforating the oesophagus.

ACHALASIA OF THE CARDIA

This type of dysphagia was in the past known as cardiospasm on the assumption that it was due to spasm of the cardiac sphincter. The term achalasia, introduced by Hurst, is preferable, as it indicates that the obstruction which undoubtedly exists, is due to a failure to relax rather than to increased tone. The condition is not uncommon, and in 30% of patients is the most frequent cause of obstruction at the lower end of the oesophagus.

Pathology—No organic obstruction is found at the cardiac sphincter, and the muscle fibres in this region show no signs of any hypertrophy. Normally, a peristaltic wave passing down the oesophagus is accompanied by relaxation of the sphincter. In achalasia this does not occur and the swallowed food is retained in the oesophagus, which ultimately becomes enormously dilated and hypertrophied. The failure to relax is probably due to some derangement of functional or organic in the neuromuscular tissue known as Auerbach's plexus. In long standing cases, the irritation produced by stagnating food produces oesophagitis.

Symptoms—The condition is often sudden in onset with occasional remissions lasting for weeks or months. The patient feels the food stick at a point which he locates at the lower

end of the sternum, and, though he does not complain of pain, there is a feeling of discomfort and fullness in the chest due to the dilated œsophagus. Food is usually regurgitated soon after a meal, but there is no nausea or retching and the vomited material consists of whatever has been eaten, without admixture of bile or hydrochloric acid. When a considerable amount of food or drink is taken, the weight of the column of fluid in the œsophagus when the patient is standing erect, is usually sufficient to force some of the food through the sphincter. Once the condition becomes well established the cardia appears to remain permanently closed and the undernutrition results in rapid loss of weight though, in contrast to cases of carcinoma, the general condition of the patient remains fairly good. The disease may last for many years as at each meal a certain amount of food succeeds in getting past the cardia.

Diagnosis—Although the symptoms and history may strongly suggest achalasia, the diagnosis should be confirmed by the passage of the mercury tube described above (*vide p. 388*). Owing to its weight, this readily forces the cardiac sphincter open and passes into the stomach without any appreciable resistance. A ray shows a greatly dilated œsophagus with vigorous peristaltic waves, the lower end of the œsophagus has a perfectly regular outline, which is quite different in appearance from the irregularity which is usually seen even in an early carcinoma (see Plates 14 and 15). When the condition is intermittent, it is important to make the X-ray examination at a time when symptoms are present and to use an opaque meal which is semi solid in consistency.

Treatment—Dilatation of the sphincter by the passage of the mercury tube is sometimes sufficient to effect a permanent cure if treatment is started early. The patient can readily pass the tube himself and should do so before each meal. When the condition has been present for years and the œsophagus is much dilated, cure is unusual, but daily dilatation enables the patient to live in comparative comfort. When there is much œsophagitis lavage with normal saline is advisable. In very intractable cases in which the mercury tube fails to pass through the cardia owing to kinking of the œsophagus the cardiac orifice may be dilated manually when the stomach has been opened at a laparotomy.

PRESSURE ON THE ŒSOPHAGUS FROM WITHOUT

Dysphagia due to aortic aneurysm or mediastinal tumour is rare and other symptoms usually point to the correct diagnosis.

Diverticula of the Œsophagus—These are of two types pulsion and traction diverticula. As their names imply the pulsion type is due to pressure within the œsophagus producing a hernia through a weakened spot in the musculature while the traction types are caused by adhesions of the œsophagus to surrounding parts such as a tuberculous gland.

Pulsion diverticula are as a rule pharyngeal pouches which emerge in the posterior median line of the hypopharynx between the oblique and transverse portions of the inferior constrictor muscles. As the pouch enlarges it extends down into the posterior mediastinum and by pressure on the œsophagus produces dysphagia. Food is often regurgitated when the pouch fills. Traction diverticula are always small and rarely produce symptoms. The diagnosis is readily made with an opaque meal and X rays or by examination with the œsophagoscope. Where the symptoms are severe pulsion diverticula may be removed surgically.

HYSTERICAL DYSPHAGIA

An alleged inability to swallow is sometimes encountered in hysterical patients. Occasionally it is associated with an idea that a foreign body is lodged in the throat. The patient usually complains of a lump in the neck the so called *globus hystericus*. In this type of case solids are sometimes more easily swallowed than fluids a condition which is not likely to be present in a dysphagia due to any organic lesion. The passage of the heavy mercury tube may be useful in demonstrating to the patient that there is no blockage of the gullet though in addition treatment of the general condition by psychotherapy is of course necessary.

DISEASES OF THE STOMACH AND DUODENUM

Disease of the upper part of the alimentary tract comprising the stomach and duodenum may be classified under two general headings (1) Organic lesions such as ulcers growths or inflammations (2) functional conditions in which no local pathological lesion can be detected. The latter are commonly known as the dyspepsias and may be due to organic disease in other parts of the gastro intestinal tract such as cholecystitis or to disorders in the nervous system.

Although the diagnosis of gastric and duodenal lesions can often be made with fair certainty on the strength of a careful

history of the symptoms and a physical examination various clinical investigations are available which are of the greatest value in helping to confirm a clinical diagnosis. These are (1) X ray examination (2) fractional test meal, (3) examination of faeces for occult blood (4) gastroscopy.

X-ray Examination—Radiology is the most valuable of all special methods employed in the diagnosis of lesions in the upper alimentary tract. X ray examination of the stomach with an opaque meal gives valuable information as regards (1) the motility of the stomach and its rate of emptying (2) the presence of organic lesions such as chronic peptic ulcer, hour glass constriction or carcinoma. The first part of the duodenum is visualised as a triangular shadow just above and to the right of the pyloric end of the stomach and is known as the duodenal cap from its shape. An X ray diagnosis of duodenal ulcer may be made on persistent irregularity in the outline of the cap which in such cases is often tender on palpation.

In radiological examinations of the stomach and duodenum fluoroscopic examination by a competent radiologist is essential and may be of greater value than the taking of X ray films.

In patients liable to constipation a mass of barium in the rectum may form a ball valve obstruction which may necessitate manual removal under an anaesthetic. Plenty of paraffin should be given as early as possible after the radiological examination is completed in order to obviate this distressing result of a barium meal.

Fractional Test Meals—The patient after fasting from the previous night swallows an Lihors or Pyle's tube. All the gastric contents are aspirated and measured. The fluid obtained is known as the resting juice. A pint of fine oatmeal gruel is now swallowed with the tube still in position and specimens are aspirated at quarter hourly intervals for about three hours or until no more can be obtained. Each specimen should be about 15 c.c. in volume.

The specimens including the resting juice are examined macroscopically for the presence of blood and bile and the percentage of free acid and the total acidity are estimated quantitatively, the results being plotted on a chart as shown in Fig. 7. The variations in the percentage of free acid in normal persons are considerable and range from complete absence of free acid to extreme degrees of hyperchlorhydria. The specimens are also tested for the presence of starch and sugar and the point at which these disappear is noted as this indicates the time at which the meal has left the stomach.

If the resting juice exceeds 50 cc or contains food debris, starch, or sugar in appreciable quantities, pyloric obstruction is probable. Pus or blood in the resting juice is suggestive of gastric carcinoma.

The acidity, both free and total, will depend on a number of factors, such as the rate and amount of gastric secretion, the

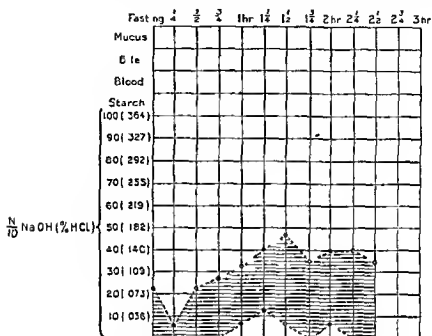


FIG. 7.—Fractional Test Meal Chart. The shaded area represents the limits of free HCl in 60 per cent of normal persons.

rate of passage of the stomach contents into the duodenum, and the regurgitation of fluid from the duodenum into the stomach. The tendency of the percentage of acid to fall after about one and a half hours is due to neutralisation by alkaline regurgitation from the duodenum, which is a feature of the normal digestive process.

The fractional test meal is of value in the diagnosis of carcinoma, in this condition the free hydrochloric acid is usually absent or diminished, and blood may be present both in the resting juice and in the subsequent specimens. Obstruction of the pylorus by a cicatrising duodenal ulcer produces an acid curve which rises steadily and remains high after several hours. With duodenal ulcer the resting juice is often highly acid, and after a preliminary fall due to dilution on drinking the meal the subsequent specimens show a rapidly rising acidity.

recognised that the condition is an extremely frequent one especially in persons of over middle age. Apart from its symptoms, the presence of gastritis may be determined by the fractional test meal X-ray examination and the gastroscope. In chronic gastritis the acidity is low, and often no free hydrochloric acid is present in any of the specimens in a fractional test meal, which however, usually contain an excess of mucus. With improved radiological technique the rugæ of the stomach can be shown to be thickened and irregular. No doubt with increased use of a flexible gastroscope there will be still further advances in our knowledge of gastritis.

The symptoms of chronic gastritis are usually characteristic. Morning anorexia, nausea and vomiting are prominent features. The vomit consists only of swallowed mucus and saliva and is small in amount. The appetite and digestion improve as the day wears on and by the evening the patient usually feels fairly fit. Sometimes there may be a sensation of fullness and discomfort in the epigastrium, but this seldom amounts to real pain. The tongue is thickly furred.

The conditions which commonly predispose to the development of chronic gastritis are given below —

- 1 Alcohol taken regularly in considerable amount
- 2 Faulty habits as regards feeding *e.g.*, hurried meals, defective mastication, excessive tea, coffee or tobacco
- 3 Septic conditions in mouth or nasopharynx
- 4 Congestion of the gastric mucous membrane in chronic heart disease
- 5 Chronic infections particularly phthisis

How far chronic gastritis can be regarded as a precursor of more serious conditions such as peptic ulcer and carcinoma remains doubtful. It is certain however that acute erosions are often present which may cause severe hæmorrhage, and quite possibly develop into chronic peptic ulcer.

Treatment consists in persuading the patient to readjust his daily routine, where this appears to be at fault. Perhaps the easiest method of achieving this object is spa treatment, where regular habits and diet often work wonders, quite apart from the virtues of the waters. Septic teeth or gums must be dealt with. Even in cases in which alcohol is not the cause

organic disease of the stomach in doubtful cases. Needless to say, the gastroscope is only of value in the hands of one who has had considerable experience.

ORGANIC DISEASES OF THE STOMACH AND DUODENUM

ACUTE GASTRITIS

Acute Gastritis.—This affection is so common that there can be but few readers who have not had personal experience of it. The most frequent causes are excessive consumption of alcohol or the eating of food that has undergone decomposition as the result of bacterial action. As a rule epigastric discomfort rather than pain, nausea, a furred tongue and vomiting are the most prominent features. In mild attacks fever is absent, but in more severe cases, especially in those due to food poisoning, the temperature may be raised. If the intestines be involved, as is often the case, diarrhoea occurs. This is particularly likely to be so in infants. During the acute stage the patient has marked anorexia. The vomit contains no free acid, but there is considerable excess of mucus. The gastric contents are often retained in the stomach for an abnormally long period. Attacks of acute gastritis may undoubtedly be provoked by chill, especially in the tropics. The treatment of gastritis due to food poisoning is described elsewhere (*vide* p. 257). A tepid drink containing a drachm of sodium bicarbonate will often provoke vomiting and give relief. Most cases cure themselves, as abstinence from food for some hours is usually all that is required for a return to normal. Kaolin ($\frac{1}{2}$ to 1 oz.) is often beneficial.

Acute gastritis also occurs in acute infections, such as scarlet fever and influenza, particularly at the onset of the disease.

Acute Phlegmonous Gastritis.—This condition results from the swallowing of corrosive poisons such as strong acids or alkalis. The mucous membrane may be completely destroyed. There is intense pain, with vomiting and collapse; in severe cases death occurs rapidly. If recovery takes place, cicatricial stenosis of the pylorus may occur.

CHRONIC GASTRITIS

Whereas in the past chronic gastritis was common among alcoholics, it is now be-

with an increased rapidity of the passage of the meal out of the stomach. Normally the stomach should be empty, as judged by the absence of starch and sugar, within about two and a quarter hours. Ulcers of the body of the stomach do not as a rule exhibit any typical type of test meal curve.

Even when no free acid is present in any of the specimens of gastric juice withdrawn, hypodermic injection of $\frac{1}{2}$ milligramme of histamine may sometimes stimulate a secretion of acid. When histamine fails to produce any acid the patient is said to have achylia gastrica rather than achlorhydria. Nearly all patients with pernicious anaemia show gastric achylia. After gastro jejunostomy operations achlorhydria is frequently present owing to the neutralisation of the gastric juice by alkaline secretion from the duodenum.

Occult Blood in the Faeces—The patient must not take any meat, fish or green vegetables for at least three days before the test. Provided bleeding from the gums is excluded the finding of occult blood indicates bleeding from the alimentary tract. The examination should include a guaiac or benzidine test and spectroscopic examination for haematin, porphyrin and acid haematin. The finding of haematoporphyrin shows that the bleeding is from the upper alimentary tract, and when acid haematin is present the amount of bleeding is considerable as for example in gastric carcinoma.

Gastroscopy—The introduction of the Schindler flexible gastroscope in 1932 has been of great value in relation to both the diagnosis and treatment of diseases of the stomach. With this instrument the greater part of the stomach can be visualised and the discomfort to the patient is almost negligible.

The gastroscope is an aid to diagnosis in (1) shallow gastric ulcers and erosions which the X ray fails to visualise, (2) inflammatory or ulcerative conditions around a gastro jejunal stoma, (3) chronic gastritis with or without erosions. Thus it may be of great value in revealing the cause of haematemesis in cases where the X ray findings have been negative.

Gastroscopy is also of value in controlling the medical treatment of gastric ulcer. Even when the X ray no longer shows a crater and occult blood has disappeared from the faeces the gastroscope may reveal that the ulcer is not yet completely healed and that several further weeks of strict treatment are required.

Unfortunately duodenal ulcers are not visible through the gastroscope nor is the instrument of much value in deciding whether an ulcer is innocent or malignant. Negative gastroscopic findings may be however of great value in excluding

organic disease of the stomach in doubtful cases. Needless to say, the gastroscope is only of value in the hands of one who has had considerable experience.

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CHRONIC GASTRITIS

Whereas in the past chronic gastritis was only regarded as common among alcoholics it is now becoming more widely

recognised that the condition is an extremely frequent one especially in persons of over middle age. Apart from its symptoms the presence of gastritis may be determined by the fractional test meal X-ray examination and the gastroscope. In chronic gastritis the acidity is low and often no free hydrochloric acid is present in any of the specimens in a fractional test meal which however usually contain an excess of mucus. With improved radiological technique the rugæ of the stomach can be shown to be thickened and irregular. No doubt with increased use of a flexible gastroscope there will be still further advances in our knowledge of gastritis.

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How far chronic gastritis can be regarded as a precursor of more serious conditions such as peptic ulcer and carcinoma remains doubtful. It is certain however that acute erosions are often present which may cause severe hæmorrhage and quite possibly develop into chronic peptic ulcer.

Treatment consists in persuading the patient to readjust his daily routine where this appears to be at fault. Perhaps the easiest method of achieving this object is spa treatment where regular habits and diet often work wonders quite apart from the virtues of the waters. Septic teeth or gums must be dealt with. Even in cases in which alcohol is not the cause of the condition it should be absolutely forbidden at any rate for many months. A gentian and soda mixture (soda bicarb. gr 15 spirit ammon. aromat. M30 inf. gent. co. ad 3i) is often useful in stimulating the appetite. When the secretion of hydrochloric acid is diminished acidum hydrochloricum dilutum B.P. may be given in doses up to 1 drachm taken

with half a pint of sweetened lemonade at meals. In intractable cases daily lavage of the stomach before breakfast with hydrogen peroxide (1 drachm to a pint of water) may be tried. When gastric symptoms are secondary to other diseases such as phthisis or cardiac failure the treatment is that of the primary condition.

If a further test meal be performed after effective treatment the gastric acidity is often found to have returned.

HÆMATEMESIS

Although hæmatemesis is most commonly due to hæmorrhage from a gastric or duodenal ulcer it often results from other pathological conditions. The causes of vomiting of blood are tabulated below—

- 1 Vomiting of swallowed blood *e.g.* following epistaxis
- 2 Bleeding from the œsophagus due to rupture of an œsophageal varix in cirrhosis or very rarely to rupture of an aortic aneurysm
- 3 Bleeding from the stomach due to—
 - (a) Acute erosion or ulcer
 - (b) Chronic ulcer
 - (c) Dilated veins around cardiac orifice in cirrhosis
 - (d) Carcinoma
 - (e) Irritant poisons *e.g.* arsenic
 - (f) Severe gastritis and vomiting
 - (g) Gastric polyps and adenomata (rare)
- 4 Bleeding from the duodenum due to an acute or chronic peptic ulcer
- 5 Hæmatemesis in certain acute infective diseases *e.g.* malaria yellow fever
- 6 Hæmatemesis in diseases of the blood splenic anæmia purpura hæmorrhagica scurvy leukæmia

Differential diagnosis of the cause of the hæmorrhage is often easy from the history of the patient. Symptoms sometimes of long duration may point to a chronic gastric or duodenal ulcer. Severe hæmorrhage however is not uncommon from an acute ulcer or multiple erosions without any previous history of dyspepsia. Symptoms of a chronic gastritis particularly if associated with a history of alcoholism suggest cirrhosis. Splenic anæmia may produce copious hæmatemesis but the much enlarged spleen and leucopenia render diagnosis easy. With hæmatemesis due to purpura hæmorrhagica or leukæmia

there is also evidence of hæmorrhages elsewhere, such as ecchymoses in the skin, epistaxis, or bleeding from the gums

Sometimes there may be difficulty in differentiating between hæmatemesis and hæmoptysis. The patient's own sensations are a valuable guide, but apart from this, an inspection of the material brought up is generally sufficient. With hæmatemesis there are often remnants of food mixed with the blood, in hæmoptysis the blood is often frothy and bright red, and blood streaked sputum continues to be coughed up after the acute hæmoptysis has ceased.

Treatment of Hæmatemesis—It is unwise to carry out any thorough physical examination until hæmatemesis has ceased for several days. Palpation of the abdomen is particularly to be avoided as it may dislodge clot and lead to further hæmorrhage. The immediate treatment required is the same irrespective of whether the hæmorrhage is due to ulcer, cirrhosis or gastritis.

The first and most important point in the treatment of hæmatemesis is to put the patient at absolute rest, strict confinement to bed with the head unsupported by a pillow is essential, all visitors or disturbance of any kind must be absolutely forbidden. As soon as possible $\frac{1}{2}$ gr of morphia must be given hypodermically and this should be repeated at four or six hourly intervals as long as there is any restlessness or continuance of hæmorrhage, as judged by a rising pulse rate and a falling blood pressure. Atropine gr $\frac{1}{100}$ should also be given, as this drug diminishes the secretion of acid and also helps to prevent œdema of the lungs. Nothing should be given by mouth except small bits of ice or sips of water. Rectal salines with 5 per cent glucose should be given slowly with a drip feed.

As the patient is usually shocked and dehydrated, the mouth is very dry and should be carefully cleaned at frequent intervals to diminish the risk of parotitis. The patient's pulse should be charted hourly and the blood pressure estimated at least thrice daily. A rising pulse and falling blood pressure are indications that bleeding has not ceased, even though there may have been no further hæmatemesis. A blood count should be done and the blood group determined even in mild cases.

Indications for Transfusion—It is impossible to lay down any hard and fast rules as to when blood transfusion is necessary. The percentage of hæmoglobin is of little aid and especially during the first forty-eight hours, it may remain quite high even though the amount of blood lost has been

very large. The hæmoglobin often continues to fall after hæmorrhage has ceased, as the blood volume is made up to normal by fluid from the tissues. The main indications for transfusion are severe shock and collapse, a pulse rate rising to 120 or above, and a systolic blood pressure falling to 100 mm or below. Intravenous saline or gum should not be given unless it is impossible to do a blood transfusion. A series of small transfusions of not more than 10 oz each are preferable to larger transfusions, but probably the safest method is a continuous drip transfusion, which enables blood to be given slowly over a period of many hours or even days.

Operation is almost always contraindicated during or immediately after hæmatemesis. If the bleeding is due to an acute ulcer or erosion, no surgical procedure can be of any avail, while the immediate operative mortality is necessarily high. Very rarely when a chronic gastric ulcer is known to be present and appears to have eroded an artery, bleeding continues in spite of all medical measures, and operation may be tried as a last resort. In such cases blood transfusion by the continuous drip method may diminish the operative mortality. Naturally a severe hæmatemesis is most alarming both to the patient and his relatives and the medical attendant must firmly refuse to allow himself to be persuaded into recommending operation except in very special cases.

When there has been no evidence of bleeding for forty-eight hours the patient may be put on to small feeds of citrated milk (sodium citrate, gr ii to 1 oz milk)—not more than 2 oz at a time—at hourly intervals. Later the diet may be gradually increased, as described in the treatment of chronic peptic ulcer. As soon as bleeding has ceased large doses of iron should be given in the form of 20 minims of a saturated solution of iron and ammonium citrate taken thrice daily in milk.

During recent years under the influence of Meulengracht, more liberal diets have been advocated for patients suffering from hæmatemesis and melaena. Meulengracht allows bread and butter, oatmeal, pounded meat and fish, mashed potatoes, vegetable purée, rice and tapioca puddings even on the first day. The patient is also given alkalis. It is claimed that hæmorrhage ceases more quickly than with a restricted diet and mortality is less. Arguments adduced in favour of Meulengracht's treatment are (1) that a high caloric diet with ample vitamins is likely to promote healing of ulcers, (2) that on restricted diets or starvation patients died of exhaustion and toxæmia, (3) that the empty stomach contains a high concentration of free acid.

In Great Britain a modified Menlengracht diet is advocated by Watts who gives on the first day two hourly feeds of egg and milk with vegetable and fruit puree and orange juice. On the second and subsequent days the diet is increased by the addition of rusks, crustless bread and butter, and milk puddings.

Melæna—By melæna is meant sufficient altered blood in the feces to render them black and tarry in consistency. Following a severe hæmatemesis there is always some degree of melæna. With hæmorrhage from a duodenal gastro jejunal or jejunal ulcer melæna is a more frequent occurrence than is hæmatemesis. The amount of blood shed into the intestine may be very large and when the bleeding occurs rapidly the patient may become collapsed and unconscious within a few minutes. The treatment of melæna is similar to that for hæmatemesis. Patients with melæna often have slight pyrexia probably due to decomposing blood in the intestines.

Prognosis—Comparatively few patients die directly as a result of hæmorrhage from a peptic ulcer. When death does occur it is usually due to recurrent or persistent bleeding from an artery exposed in the floor of an ulcer. The outlook is worst in patients with arteriosclerosis. Estimates of the mortality in cases of hæmorrhage are remarkably conflicting and vary from about 2 per cent to about 25 per cent. There is no evidence that early surgical treatment has better results than medical.

GASTRIC AND DUODENAL ULCER

Although there are striking differences between gastric and duodenal ulcers particularly as regards their symptomatology it is permissible to consider them together, as their pathology and their medical treatment are very similar if not identical. The frequency of peptic ulcer, under which term are included both gastric and duodenal ulcer, appears to have increased very greatly during the past thirty years. To some extent the apparent increase is due to better facilities for diagnosis but there can be no doubt that there has also been a real increase especially in the frequency of duodenal ulcer. Probably an important factor is the general 'speeding up' of life during the present century, with its encroachments on the more placid atmosphere of the Victorian era.

It is unnecessary to consider in detail the statistics of age and sex incidence of peptic ulcer. Duodenal ulcer is at least

three times more common in males than in females, and gastric ulcer is relatively more frequent in females. As the onset is usually very insidious it is often difficult to be certain at what age the disease really started, but severe symptoms from peptic ulcers are more common above the age of forty than in earlier life. Occasionally there is a striking incidence of duodenal ulcer among the members of a family.

Pathogenesis—In spite of the great amount of experimental work that has been carried out on the pathology of peptic ulcer, it must be admitted that the cause of the condition is still undecided. The one outstanding fact is that peptic ulcers only occur in those parts of the alimentary canal in which gastric juice is present. This includes the stomach, the first part of the duodenum, and, in cases where a gastro jejunostomy has been performed, the first few inches of jejunum from the point where it is sutured to the stomach. The natural inference from this is that the gastric juice or perhaps its hydrochloric acid, is in some way responsible. Although gastric juice is unable to digest the normal mucous membrane of the stomach, it is possible that if this becomes devitalised either by trauma, toxins or local circulatory disturbances, digestion of an area of mucous membrane may occur, leading to the formation of an acute ulcer. Although hydrochloric acid is not necessarily present in excess in all cases of peptic ulcer, there is usually some degree of hyperchlorhydria, particularly in duodenal ulcer, and it may be that it is the presence of free hydrochloric acid which prevents the healing of an acute ulcer. The importance of focal infection as a cause of peptic ulcer remains undecided. Much stress has recently been laid upon the fact that the symptoms of peptic ulcer frequently follow emotional disturbances and anxiety, and it has even been maintained that emotional factors are of *primo* importance in the development of peptic ulceration. Although it is undoubtedly true that psychological factors are of great importance, it is difficult to imagine that they play more than a contributory part in the genesis of ulcer.

Examination of portions of the stomach removed at operation in cases of gastric ulcer show that quite apart from the ulcer there are inflammatory changes in the mucous membrane. These changes may be acute gastritis, sometimes with small superficial erosions or a chronic hypertrophic gastritis. Gastroscopic examination also shows that gastritis is often present in cases of peptic ulcer. It is possible that gastritis may be a predisposing factor in the formation of chronic peptic ulcer.

Hurst has pointed out that duodenal ulcer is especially

* On examining the abdomen there is tenderness on deep pressure in the epigastrium, particularly just to the left of the midline. This is most obvious when there is spontaneous pain at the time of the examination. Rigidity is unusual unless the ulcer is involving the peritoneum, and a palpable tumour is very rare and suggests carcinoma rather than ulcer.

A test meal usually gives little help in the diagnosis unless pyloric obstruction is present. X-ray examination should demonstrate an ulcer in over 90 per cent of cases. A projection or niche is seen filled with the opaque salt and when the ulcer is on the lesser curvature an menura is often visible, due to spasm of the circular muscle fibres.

Symptoms of Duodenal Ulcer.—These are even more typical than those of gastric ulcer. Periods of complete remission of symptoms are more marked than in gastric ulcer, and may last months or even years. Exacerbations are particularly common during the spring and autumn, or when the patient is overworked or worried. The pain in duodenal ulcer occurs at a longer interval after food than in gastric ulcer, often as long as three hours, so that it tends to appear before a meal rather than after one, and is often termed 'hunger pain'. The appetite is good, but the patient is afraid to eat. Relief is obtained as the result of taking food or alkalis. Vomiting is rare in duodenal ulcer unless cicatrization is producing pyloric obstruction. The patient is often awakened in the early hours of the morning by pain, and learns for himself that it can be relieved by drinking a glass of milk or eating a biscuit. If an artery be eroded, both hæmatemesis and mælena may occur. Even if there be no visible hæmorrhage, occult blood is found in the fæces. On palpation of the abdomen there is usually deep tenderness in the epigastrium slightly to the right of the midline.

A test meal shows a highly acid resting juice with a rapid rise in acidity during the first hour and sometimes a rather rapid emptying of the stomach. The X-ray diagnosis of duodenal ulcer depends on the demonstration of a deformity of the duodenal cap together with local tenderness on palpation under the fluorescent screen.

Diagnosis of Gastric and Duodenal Ulcer.—A diagnosis has to be made from chronic gastritis, carcinoma of the stomach and cholecystitis. The points to be considered are set out in tabular form on the following page.

A further point in cholecystitis is local tenderness on palpation over the gall bladder, especially when the patient takes a deep inspiration. Although obvious mælena seldom occurs in

	Gastric Ulcer	Duodenal Ulcer	Carcinoma	Cholecystitis	Chronic Gastritis
Pain					
Relation to meals	1 1½ hrs	2 3½ hrs	Often immediate	Irregular	Usually slight
Relief by food	Uncommon	Very common	Never	Variable	Not relieved
Relief by alkali	Usually	Usually	No relief	Usually not	Not relieved
Appetite	Modest	Good	Very bad	Variable	Bad in morning
Vomiting	Common	Very rare	Very common	Usually none	In morning
Hæmatemesia	Fairly common	Fairly common	Coffee grounds	None	Rare
Occult blood in feces	Constant	Constant	Invariable	Sometimes	Sometimes
Acid in test meal	Normal	High	Absent or low	Variable	Usually low
Loss of weight	Slight	Slight	Early and marked	None	None

carcinoma the presence of occult blood in considerable amount is invariable

Although the symptoms of chronic peptic ulcers particularly duodenal are usually fairly characteristic there are many occasions on which even a careful consideration of the patient's history and a thorough physical examination fail to point to a diagnosis of a peptic ulcer which may yet be demonstrated without doubt by X-ray examination. Conversely, X-ray examination may be negative when on clinical grounds an ulcer is almost certainly present.

COMPLICATIONS OF GASTRIC AND DUODENAL ULCER

Hæmorrhage and perforation are the two most frequent complications of a peptic ulcer, and they may occur both with acute and chronic ulcers. Hæmatemesia has already been described (*vide p. 397*) and perforation is a surgical condition which is dealt with in textbooks of surgery. Other important complications of chronic ulcers are pyloric stenosis and hour-glass constriction. In addition there are complications which may arise following surgical interference: these include jejunal and gastro-jejunal ulcers and gastro-colic fistula.

Hour-glass Constriction.—This rather infrequent complication of a gastric ulcer on the lesser curvature is practically



PLATE 16—Hour glass Constriction of Stomach The arrow indicates niche ' of ulcer (From Plate by Dr P J Briggs)

confined to females. The patient gives a history of attacks of indigestion for many years before the more serious symptoms of an hour glass stomach become manifest. As a result of cicatrization the stomach becomes divided into an upper and lower pouch with a narrow constriction between the two. When there is serious obstruction to the passage of food the patient vomits almost immediately after a meal and becomes very wasted and cachectic. Abdominal pain is variable. Patients with advanced hour glass constriction are usually diagnosed as suffering from carcinoma of the stomach, until the correct diagnosis is established by X ray examination. The treatment of the condition is surgical.

Apart from hour glass stomach described above, where there is an organic stricture, there is another condition sometimes termed a spasmodic hour glass constriction. Here an ulcer on the lesser curvature produces a reflex spasm of the circular muscle fibres opposite it, and this results in an incision on the greater curvature opposite the site of the ulcer. The condition of spasm is temporary and disappears when the ulcer heals. Spasmodic hour glass constriction calls for no special treatment apart from that of the ulcer.

Pyloric Stenosis — The most frequent cause of pyloric stenosis is cicatrization of a duodenal ulcer. Gastric ulcers rarely produce obstruction of the pylorus, but the condition is common in carcinomata of the pyloric antrum.

Pyloric stenosis can, as a rule, be diagnosed with considerable certainty from the patient's symptoms and physical signs. The most important symptom is the vomiting of very large quantities of fluid, containing food, some of which may be recognised as having been eaten many hours or even days previously. Vomiting is relatively infrequent, seldom more often than once in twenty four hours, but if the stomach has become very dilated and atonic, its contents may be vomited only every two or three days. Pain is generally not a striking feature unless the obstruction is due to a growth. The patient suffers from marked manition whether the stenosis be due to ulcer or growth. Owing to gastric stasis fermentation occurs and the eructated gas has a foul odour, particularly when the stenosis is due to carcinoma.

On physical examination the abdomen often looks strikingly distended in contrast to the general wasting. The outline of the dilated stomach can usually be seen and waves of peristalsis are visible passing across the abdomen from left to right. There is also a loud succussion splash. The diagnosis is readily confirmed by X ray examination, which shows very deep and

powerful peristaltic waves which start nearer the cardiac end of the stomach than they normally do. Pe examination after six hours shows most of the opaque meal still remaining in the stomach. A fractional test meal gives important information. With a cicatricial stenosis the amount of free acid rises steadily in the later specimens but in obstruction due to a carcinoma there is little or no free hydrochloric acid throughout and altered blood is present in considerable amount.

Patients with pyloric stenosis due to cicatrization of an ulcer usually have a history of duodenal symptoms extending over many years. With a carcinomatous obstruction the history is a short one.

In some cases of ulcer near the pylorus whether gastric or duodenal there may be pylorospasm quite apart from any organic stenosis. With strict dietetic treatment alkali and atropine the spasm may disappear. Although there may be definite gastric delay in such cases no visible peristalsis is seen and the amounts vomited are not as great as they are in true pyloric stenosis. Gastro jejunostomy is inadvisable in pylorospasm unless there is organic stenosis in addition.

Gastric Uræmia—In pyloric stenosis and sometimes in peptic ulcer apart from pyloric stenosis a condition of *allalosis* may develop giving rise to symptoms sometimes described as gastric uræmia. These are drowsiness, headache, thirst, hiccups, twitching and stupor. The blood urea is high rising to 150 mgm per 100 cc or more and the chlorides are decreased. The urine often contains albumen and casts. Attacks of tetany may occur but are rare. The condition is a dangerous one particularly if it remains unrecognised. The administration of alkali must be stopped at once gastric lavage started and rectal saline given. In severe cases a continuous drip intravenous saline is required. Operation should be postponed until the blood urea has fallen and symptoms have abated.

Treatment—With severe pyloric stenosis gastro jejunostomy is most successful but before operation it is wise to wash the stomach out daily in an attempt to diminish its size and improve its tone. No alkali should be given owing to the danger of alkalosis. Even when the stenosis is due to a growth gastro jejunostomy may produce a temporary improvement.

Jejunal and Gastro jejunal Ulcer—This is a serious and unfortunately relatively common complication following gastro jejunostomy particularly when this operation has been performed on a patient with a high gastric acidity. The most

prominent symptom is pain which usually comes on soon after food and yields much less readily to dietetic and medicinal treatment than does the pain of a gastric or duodenal ulcer. Melæna is also frequent and may be extremely severe. A majority of jejunal and gastro jejunal ulcers occur within two years of operation but they may develop after almost any length of time. Prolonged and strict medical treatment is essential but often further surgical treatment is eventually necessary which unfortunately is by no means always successful.

Gastro-colic Fistula—In this dangerous condition a fistula forms between the stomach and the colon usually following gastro jejunal ulceration. The patient becomes very emaciated and suffers from chronic diarrhoea with faeculent eructations. Operative treatment is essential but the mortality is high.

TREATMENT OF GASTRIC AND DUODENAL ULCER

The most important points in the treatment of peptic ulcer are physical and mental rest. The former can be attained by keeping the patient in bed though he can be allowed to use the lavatory and bath. Exclusion of business worries and in nervous or irritable patients $\frac{1}{2}$ gr doses of phenobarbitone twice a day have a good psychological effect. On such a regime even without special diet or alkalis symptoms usually are rapidly relieved.

As regards diet there is a wide variation in the practice of physicians ranging from the strict hourly feed diet of Hurst to the far more liberal diet advocated originally by Meulen gracht. Probably as satisfactory as any are two hourly feeds of non irritating non stimulating character the basis of which is milk and farinaceous food. The calory content must be adequate certainly not less than 2 000 calories daily and there must also be sufficient protein and vitamins. Obviously food containing gross roughage *e.g.* cabbage tips or skins of fruit are inadvisable as are spices condiments and meat extracts which induce gastric hypersecretion. Smoking should be entirely forbidden during the course of treatment.

Hourly feeds are practically impossible except in hospital and it is by no means certain that they have any real advantage over feeds at two hourly intervals. The following scheme of diet is usually satisfactory—

1 *First Meal*—Two hourly feeds of milk arrowroot Benger's food Horlick's Ovaltine cornflour. Sugar should be added to taste and the juice of an orange.

2 *Second Week* —Thin white bread and butter with fruit jelly, eggs, custards, milk jellies potato or vegetable puree can be substituted for some of the feeds

3 *Third and Subsequent Weeks* —Boiled or steamed fish minced chicken, weak tea can be added to the diet of earlier weeks

Medicinal Treatment —Olive oil to diminish gastric secretion alkalis to neutralise hyperacidity, and atropine as an anti-spasmodic have long been employed in the treatment of peptic ulcer. Whether they are as important as was formerly imagined is doubtful. Atropine or belladonna has probably little effect in the doses normally employed and may well be omitted during routine treatment. If the patient however, awakes with pain during the night $\frac{1}{16}$ gr. of atropine hypodermically last thing at night is often helpful. The value of olive oil or cream is doubtful and in any case they are under war conditions impracticable. The majority of physicians still give alkalis. Probably the two most effective antacids are magnesium trisilicate in 15 gr. doses between feeds and colloidal aluminum hydroxide in 1 to 2 drachm doses. Neither of these drugs produce alkalosis.

Treatment on the lines given above should be adhered to for at least five weeks, even though symptoms may have completely disappeared. The effects of treatment may be controlled (1) by X ray examinations, (2) by examination of the stools for occult blood. In the case of a gastric ulcer, the "niche" seen with the X rays often diminishes in size or even disappears within a month of strict treatment being instituted, and the occult blood, which at the beginning of treatment was well marked, becomes first much reduced and finally is completely absent. With duodenal ulcers deformities of the duodenal cap may persist for many months or even years after all symptoms and signs have disappeared. Gastroscopy is also of great value in determining whether a gastric ulcer has healed completely.

In addition to dietetic and medicinal treatment, it is important to eradicate focal sepsis. The teeth should be X rayed and any found to be infected should be extracted. If pyorrhoea is present extraction is usually indicated. Infected tonsils should also be dealt with surgically.

Injectations of histidine are of no value.

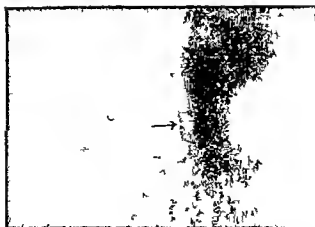
A patient who has suffered from chronic gastric or duodenal ulcer is very liable to recurrence of his ulcer unless he is very careful as to his diet and the general régime of life. He must avoid overwork and worry, take regular meals and allow himself



(a) Before treatment



(b) After 2 months



(c) After 7 months

PLATE 17—Series of three plates showing diminution in the size of niche under medical treatment (a) Original size of niche (b) 2 months later (c) 7 months later (From Plates by Dr P J Briggs)

plenty of time to eat them. Alcohol in all forms is best avoided for at least a year, and after that period must be taken in only very moderate quantities. Anything in the nature of short drinks before meals should be permanently forbidden. Smoking should be completely stopped for at least six months and over-smoking rigorously avoided later. Fresh fruit with skins and pips are to be avoided as are condiments such as vinegar and mustard and highly spiced foods. Regular visits should be paid to a dental surgeon at not more than six monthly intervals. If there is a tendency to constipation liquid paraffin should be taken. For three months after strict treatment has ceased it is wise to avoid meat completely but fish and chicken may be allowed. For six months an antacid such as magnesium trisilicate should be taken with the three main meals or if for any reason a meal is missed. In cases of duodenal ulcer it is essential to continue permanently to take rather small meals with small intermediate feeds between meals. In the event of the return of symptoms however slight the patient should rest for a few days on a strict diet of milk in small and frequent feeds. Drugs in tablet form especially aspirin must be crushed before swallowing.

Indications for Operation—Perforation calls for immediate operation. When hæmorrhage occurs immediate operation is almost invariably contraindicated (*vide p 399*). Complications such as organic hour glass constriction cicatricial pyloric stenosis and gastro colic fistula cannot be cured by medical treatment and are only amenable to surgery. In the case of gastric ulcer where there is doubt as to the possibility of carcinoma laparotomy should be performed but the theoretical possibility that carcinoma may develop in a benign ulcer does not justify operation.

Apart from the conditions detailed above every patient with a peptic ulcer should undergo a strict course of medical treatment before operation is even considered. If relapse occurs after one or more courses of strict treatment efficiently and conscientiously carried out the problem becomes a difficult one. In such cases particularly when severe hæmorrhage has occurred repeatedly operation may have to be advised. It must be remembered that if the patient has a high gastric acidity and the stomach empties rapidly the risks of recurrent jejunal or gastro jejunal ulceration are very considerable if a gastro jejunostomy be performed. The various operative procedures for peptic ulceration cannot be discussed here but in general it can be said that gastro jejunostomy is usually extremely successful in cases of pyloric stenosis. A patient

who relapses after operation is usually more intractable than one who has not been operated on, and further operations on such patients rarely lead to satisfactory results

It must not be imagined that surgical treatment will cure a peptic ulcer rapidly. Operation must be regarded merely as an incident in the medical treatment and the patient should be instructed to take all the precautions as to diet and mode of life which have been detailed above

Prognosis—Acute ulcers, even though hæmorrhage or perforation may have occurred usually heal rapidly, and provided that all sources of sepsis and gastritis are eliminated recurrence is unusual

As regards chronic ulcers, permanent cure whether by medical or surgical treatment is improbable (1) if the ulcer has been present for over five years (2) if the patient is over fifty five years of age (3) if his temperament is such that he is unlikely to submit to prolonged treatment and certain permanent restrictions, (4) if the environment, economic or domestic is unfavourable. Patients under forty in whom symptoms have not been present for more than two years have a more favourable prognosis

The risk of carcinoma developing in a gastric ulcer is small in a duodenal ulcer none. Surgery is extremely successful in pyloric stenosis or hour glass stomach and in these conditions permanently good results are claimed in 80 to 90 per cent of cases. Complications such as jejunal ulcer or gastro jejunal ulcer always have a bad prognosis and permanent invalidism is a frequent sequel whether such cases are treated by medical or surgical means

CARCINOMA OF THE STOMACH

Carcinoma is practically the only malignant growth which occurs in the stomach though occasionally sarcomata have been described. It is most frequent between the ages of forty and sixty but may occasionally be encountered below thirty. The disease is more common in males than in females

It has been maintained that carcinoma of the stomach frequently originates in a chronic gastric ulcer. This view finds little support among clinicians. Were it true that any considerable proportion of cases of gastric carcinoma had their origin in chronic peptic ulcers, it would be reasonable to assume that in the previous history of patients with carcinoma, there would be symptoms indicating gastric ulceration extending

at any rate, over a number of years. This, however, is certainly not the case. Actually it is rare for patients with a long history of chronic dyspeptic symptoms to develop carcinoma. On the contrary, the disease much more commonly occurs in those whose digestion has been perfect until the onset of symptoms of carcinoma. A further strong argument against ulcer being a cause of carcinoma is the fact, granted by all, that cancer is almost unknown in the duodenum, although this is a much more common situation for peptic ulcer than is the stomach. Moreover, carcinomata of the stomach most often involve the prepyloric region whereas simple ulcer chiefly occurs about the middle of the lesser curvature. A possible explanation of the frequency of gastric cancer and its failure ever to occur in the duodenum may lie in the fact that the gastric mucosa is often affected by chronic gastritis and is far more liable to trauma from the ingestion of hard fragments of food or very hot drinks, by the time these reach the duodenum they have been diluted by the remainder of the gastric contents and are cooled to body temperature.

It cannot be stated dogmatically that carcinoma never originates in an ulcer, in fact, probably some 10 per cent of gastric carcinomata result from malignant changes in chronic ulcers. Taking the evidence as a whole, however, there is certainly no justification for the idea that a patient with gastric ulcer is specially liable to develop carcinoma.

Carcinoma may occur in any part of the stomach, but, as stated above, the commonest site is in the pyloric antrum, growths starting on the greater curvature are very uncommon, but they sometimes occur at the cardiac end of the stomach and involve the lower end of the oesophagus. Originating in the mucous membrane, the growth rapidly invades the whole of the stomach wall and metastases in the glands along the lesser curvature are an early occurrence. Later, secondary deposits occur in the liver, peritoneum, and elsewhere, leading to great enlargement of the liver, ascites, and sometimes jaundice.

Occasionally carcinomata involve practically the whole of the stomach, converting it into a rigid and rather narrow tube with thickened walls formed of infiltrating growth. This type is known as *linitis plastica* or "leather bottle" stomach.

Symptoms—The initial symptoms of carcinoma of the stomach are somewhat vague, starting with a feeling of discomfort in the epigastrium more definitely present after meals than at other times. Within a few weeks, the discomfort becomes more definitely pain, the pain in carcinoma,

however in contrast to that of peptic ulcer, is usually more or less continuous although aggravated by food. Once symptoms are thoroughly established the patient never feels really comfortable even in the period between meals. The appetite fails early in the disease and there is often a marked distaste for meat of any kind. After a short time nausea and vomiting occur but vomiting seldom completely relieves the pain and discomfort. If the growth is in the neighbourhood of the pylorus as it often is pyloric obstruction soon leads to stagnation of food in the stomach. The vomit is often foul smelling and may contain much changed blood which resembles coffee grounds in appearance but severe hæmatemesis is very rare. Loss of weight is an early feature in fact not infrequently it is this which leads the patient to seek advice rather than the dyspeptic symptoms. As the disease progresses he presents the typical cachectic appearance of cancer marked emaciation sunken eyes a loose dry skin and a complexion which is markedly pale or sometimes tinged with yellow.

Physical examination during the first few months of the disease will probably reveal nothing definite but sooner or later a tumour becomes palpable which is hard and tender. In more advanced cases there may be evidence of secondary deposits as shown by the discovery of an enlarged hard and irregular liver or a deposit of growth in the recto vesical pouch felt on rectal examination. Rarely the earliest sign to be detected is a hard enlarged gland just above the inner end of the left clavicle. The signs indicating pyloric stenosis are discussed elsewhere (*vide p. 405*).

There is a wide variation in the clinical histories of patients with carcinoma of the stomach. Sometimes the abdominal symptoms may be so slight as to escape notice until secondary deposits make their appearance. The severity of the abdominal symptoms depends in part at least on the situation of the growth if this be well away from both the pyloric and cardiac orifices no symptoms may arise until neighbouring organs are invaded or metastases occur. Growths in the cardiac portion of the stomach often give rise to few gastric symptoms but may produce a rapidly progressive dysphagia. They are easily overlooked if the cardia is not visualised at X ray examination. Probably a great deal of the cachexia is due to absorption of toxins from decomposing food in the stomach.

In a small proportion of patients with gastric carcinoma the initial symptoms may simulate those of a duodenal ulcer though relief by food and alkali is not so striking. With



PLATE 16. Carcin. max. of Carlsue Full of Stomach. (From Plate 15 of A. M. M. M.)

"leather bottle" stomach the patient may complain of a constant feeling of emptiness or hunger, but when he takes food this immediately produces feelings of distension or pain.

Diagnosis—The early diagnosis of carcinoma of the stomach is of supreme importance. If nothing is done until definite signs such as a tumour appear, the case will be then already too far advanced for radical surgical treatment. *Every patient who develops dyspeptic symptoms after the age of forty, having previously enjoyed good health, should always be viewed with suspicion as a possible case of gastric cancer.* The clinical picture seen in the early stages of the disease is so variable that reliance must not be placed on this alone to exclude the diagnosis, and the patient should at once be thoroughly investigated in order to come to a definite conclusion at the earliest possible moment. If, after a thorough investigation by all the means at our disposal, there remains a reasonable suspicion of growth, it is justifiable to advise an exploratory laparotomy. Only thus is it possible to diagnose the case sufficiently early for surgical treatment to be of real avail.

The X ray in early cases may show little beyond an absence of peristaltic waves in the affected area of the stomach wall. In advanced cases large filling defects are usually obvious. With really good X ray work probably 90 per cent of carcinomata should be diagnosable in a stage at which operation is still possible. In a "leather bottle" stomach the opaque meal runs immediately into the duodenum and no peristalsis is visible.

A test meal is of great value in the early diagnosis of cancer. Dr Golding Bird showed at Guy's Hospital in 1842 that in gastric cancer free hydrochloric acid is deficient or often completely absent. With a fractional test meal achlorhydria is present in about 60 per cent of cases and in the remainder the free acid is low. The character of the resting juice in the fractional test meal is important. It may be excessive in quantity, or contain food residue, starch, or sugar. Occasionally it has a definitely foul odour, and pus cells and red cells may be seen under the microscope. Blood, obvious to the naked eye, is often seen both in the resting juice and in the subsequent specimens. This in conjunction with absence of free hydrochloric acid, is strongly suggestive of a growth.

Great reliance is rightly placed on the presence of occult blood in the stools, provided it is found on several occasions and does not disappear with treatment. Care must always be taken to exclude bleeding from the gums as a possible explanation of continued occult blood in the stools. If there

is complete absence of blood in repeated fecal specimens is almost certain that carcinoma of the stomach is not present.

Blood counts, hemoglobin estimations and examination of the blood cells do not give much help in the diagnosis of gastric cancer. Even in quite late stages of the disease they may all appear perfectly normal though as a rule there is a degree of microcytic anemia. The real value of examination of the blood is in the differential diagnosis of carcinoma of stomach from pernicious anemia.

Differential Diagnosis—The main points in the differential diagnosis from gastric and duodenal ulcers and chronic gastritis have been summarised in the table on p. 404. Carcinoma of the colon is occasionally a difficulty but as a rule the symptoms in that disease will point to involvement of the colon (*vide* p. 1). The diagnosis from pernicious anemia is dealt with under that disease (*vide* p. 352). Carcinoma near the cardiac orifice is often misdiagnosed as an œsophageal growth.

Prognosis—If the disease has been allowed to progress for any length of time the outlook is hopeless and death is to be expected to occur within a year. Occasionally cases of an atrophic type last for as long as three years though this is very exceptional. Even if the case comes to operation sufficiently early for a partial gastrectomy to be done the outlook is poor. The immediate mortality of operation is over 20 per cent and of those who survive only about 5 per cent live more than five years without recurrence.

Treatment—Once the diagnosis is made unless the case is obviously inoperable a laparotomy should be performed. In inoperable cases the treatment can be only palliative and the later stages resolves itself into the alleviation of the pain by morphia. If this is freely used as it should be it is possible to enable the patient to die comfortably. As a rule small and frequent meals are best tolerated but the patient may be allowed to eat what he likes best. If pyloric stenosis is present palliative surgical treatment in the form of gastric jejunostomy may give temporary relief.

PARE DISORDERS OF THE STOMACH

1. **Syphilis of the Stomach**—Gummatous infiltration of the stomach is extremely rare. The symptoms resemble those of carcinoma and the diagnosis is made mainly on the Wassermann test or a history of infection. If an early syphilitic remedies prove successful in relieving the condition the diagnosis is confirmed.



PLATE 19—Congenital Short Otolithagus.
(From Plate IV O. A. MARXER)

2 Diaphragmatic Hernia—The great majority of these are congenital in origin though the condition may occasionally follow trauma or violent spasms of coughing (*e.g.*, whooping cough) in which hæmorrhage occurs into the diaphragm followed by fibrosis and stretching of muscle fibres

The organ most often herniated into the thorax is the stomach, but when there is a wide ptency in the diaphragm the colon and other abdominal viscera may be also displaced. The symptoms are very variable and may be entirely absent unless strangulation or obstruction occurs. The physical signs may resemble a left sided pneumothorax but vary with the amount of food or gas in the stomach or colon. The diagnosis is often only made as a result of an X ray examination.

Herniation of a portion of the cardiac end of the stomach may result from a congenitally short œsophagus. This results in the cardiac orifice being several inches above the diaphragm and a portion of the stomach is drawn through the relatively narrow cardiac opening in the diaphragm. The condition is often symptomless, especially until after middle age. Symptoms may result from spasm or ulceration at the cardia or from partial obstruction at the level where the stomach passes through the diaphragm. The stomach may become divided into two pouches and stomach contents collect in the upper one situated within the thorax. This may produce feelings of distension and discomfort suggestive of cholecystitis. There may be also a variable degree of dysphagia with ptialism or regurgitation of food and saliva. A definite diagnosis is only likely to be made if the patient is examined with a barium meal in the Trendelenberg position.

Some forms of diaphragmatic hernia can be dealt with satisfactorily by surgery. Those due to a short œsophagus may in some cases obtain some relief of symptoms by dilatation through an œsophagoscope.

3 Acute Dilatation of the Stomach—In this rare condition there is a sudden dilatation of the stomach, which produces extreme abdominal distension, vomiting, and collapse. Such dilatation occurs most often following abdominal operations but it is not unknown as a rare complication of acute infections such as pneumonia. It is frequently fatal.

Vigorous treatment is necessary. An Einhorn's tube must be passed and the stomach kept empty by continuous suction. Nothing should be taken by mouth, but rectal or intravenous saline is beneficial.

Atonic dilatation of the stomach is often described as

occurring in patients suffering from malnutrition and neurasthenia. There is little evidence that this is so and a true atonic dilatation is practically confined to cases of severe pyloric stenosis.

FUNCTIONAL DISORDERS OF THE STOMACH

Patients who suffer from demonstrable pathological conditions of the stomach, such as growths, ulcers, or gastritis, form but a small proportion of those who complain of symptoms referred to the digestive tract. Every practitioner encounters daily, patients with symptoms such as abdominal pain or discomfort, distension, flatulence, nausea, vomiting, heartburn or acid regurgitations, where there does not appear to be any evidence of gross organic disease in the stomach or duodenum. In a proportion of such cases the gastric symptoms may be shown to be secondary to local disease elsewhere in the abdomen, for example, cholecystitis or appendicitis, and these conditions may be described as reflex dyspepsia. In others the failure of digestion appears to be the result of defective nervous control of the secretory and peristaltic functions, and the symptoms produced are termed nervous dyspepsia.

Before proceeding to describe in detail the clinical features of the dyspepsias, it is necessary to discuss some of the main symptoms of which these patients complain.

Flatulence—Most patients use the term flatulence to describe the eructation of wind from either the mouth or the bowel, and it is important, when questioning a patient who complains of flatulence, to ascertain the exact nature of the symptom, as gastric flatulence and colonic flatulence are likely to have quite different causes. Most patients with gastric flatulence also complain of sensations of fullness and distension in the upper abdomen or lower part of the chest. The distension produces abdominal discomfort rather than real pain.

In the vast majority of cases of gastric flatulence the eructated gas is odourless. When this is not the case the patient is probably suffering from pyloric obstruction or gastro colic fistula.

Contrary to the belief of most patients who suffer from flatulence, the eructated gas is not a product of abnormal fermentation in the stomach, but is merely air which has been swallowed. The presence of a certain amount of air in the stomach is invariable, but it may be very much increased by the constant swallowing of air (aerophagy). Relief is obtained

when the patient eructates, but, unfortunately, repeated attempts to do so result in the swallowing of still more air, some portion of which passes into the small intestine, where it produces loud rumblings and borborygmi, which still further distress and embarrass the patient.

Although flatulence of the gastric type is often no evidence of organic disease, it is important to realise that it is frequently a symptom associated with pathological conditions in the gastro-intestinal tract. Chronic cholecystitis, either with or without gall stones, almost invariably causes flatulence and distension, which are due in part to aerophagy but also to disordered gastric motility secondary to inflammation of the gall bladder. Flatulence is also sometimes a feature of carcinoma of the stomach and of duodenal ulcer, in the latter case it is usually accompanied by epigastric pain of duodenal type. Flatulence also results from hastily bolted meals and defective mastication.

Flatulence is a symptom which varies very much in severity. Patients who eructate like the eruptions of a miniature volcano are less likely to have any underlying organic disease than are those who suffer from more or less silent flatulence. If a patient with severe flatulence is carefully watched, frequent gulping of air can be readily detected. In such cases the mechanism of the condition must be explained to the patient, and particular emphasis be laid on the fact that the regurgitated gas is not the product of fermentation or acidity. Strict injunctions should be given that on no account should the patient attempt to "bring up wind." Once the habit of aerophagy has been established it becomes a reflex, and the patient has an overwhelming desire to swallow. As this mainly occurs after meals, it is a good plan to instruct the patient to hold a cork between his teeth for half an hour after each meal or whenever he feels distended. This acts as a gag and keeps the mouth open, thereby inhibiting attempts to swallow. Such a procedure, provided it has been preceded by explanation and reassurance, may effect a dramatic cure.

Aerophagy and cructation can be performed voluntarily. In the East guests at feasts eructate loudly at frequent intervals as a mark of their appreciation of the fare provided, and the guest who does not conform by swallowing adequate amounts of air is thought to be lacking in courtesy.

Acidity.—Many dyspeptics complain of what they term acidity. Usually this is purely an assumption on their part, suggested by the advertisements of patent medicines which purport to remedy the condition. There is, indeed, no evidence that hyperchlorhydria necessarily produces any symptoms, and

it is quite common to find that a test meal done on one who considers himself a martyr to acidity may show hypochlorhydria or even a complete absence of acid. The only symptom which gives definite evidence of abnormal acidity is acid regurgitation. This is characterised by sudden regurgitation into the throat and mouth of sour, burning fluid. It is not met with very commonly, but may occur in patients with duodenal ulcer.

Heartburn—The sensation so described is one of burning along the course of the oesophagus. The area in which it may occur ranges along a vertical line extending from the xiphisternum upwards into the neck. The sensation may last for a few minutes only, or sometimes for longer periods. It does not necessarily indicate hyperchlorhydria, and is probably due to tonic contractions in the circular muscle of the oesophagus. Heartburn is a frequent symptom in patients who are overworked, over anxious or fatigued. Dietetic readjustments, a holiday, and a little sodium bicarbonate are valuable curative measures.

Waterbrash—By this is meant the presence in the mouth of clear watery fluid without any of the burning or acid character of acid regurgitation. It is probably a sudden and excessive salivary secretion akin to ptyalism. Though it may be associated with duodenal ulcer or gastritis, it often occurs in the absence of any demonstrable organic lesion.

Abdominal Pain—It has already been mentioned that pain is not a frequent feature of dyspepsia, unless there is a definite lesion such as an ulcer. Sometimes, however, patients complain of hunger pain in the epigastrium. Often this is more a sensation of sinking than actual pain. Whether hunger pain is associated with a duodenal ulcer or not, it is aggravated by worry, fatigue, and cold, and often relieved by relaxation and a holiday. Hunger pain, though most commonly encountered with a duodenal ulcer, also occurs in biliary dyspepsia. Sometimes it is dependent on over smoking. It is probably produced by excessive peristaltic activity in the pyloric end of the stomach with some degree of pylorospasm. Needless to say, hunger pain should never be regarded as a functional disorder until the most searching investigations have as far as possible ruled out the presence of a duodenal ulcer or other pathological condition.

Nausea and Vomiting—These symptoms are frequent in patients with organic disease, but also occur with reflex dyspepsia particularly when this is due to cholecystitis. They may, however, also occur as the result of emotional upsets. Repeated vomiting, particularly immediately after

food, is often hysterical in origin. In such cases only a portion of the meal is vomited, and undernutrition is not striking in relationship to the frequency of the vomiting. Psychotherapy and firm handling usually produce a rapid disappearance of symptoms.

REFLEX DYSPEPSIAS

The most frequent cause of reflex dyspepsia is chronic *cholecystitis*, the symptoms of which are described elsewhere (*vide p 469*). Dyspeptic symptoms are also frequently ascribed, perhaps too frequently, to chronic *appendicitis* (*vide p 133*).

A rather uncommon form of reflex dyspepsia is that which may result from an epigastric hernia. If the linea alba between the umbilicus and the xiphisternum is examined, a small tender lump can be felt, which is a protrusion of extra peritoneal fat through a small opening in the linea alba. Epigastric hernias do not necessarily cause symptoms, and it is important before making a diagnosis of dyspepsia due to this cause to exclude other conditions.

Apart from reflex dyspepsia digestive disturbances are often due to faulty habits. Chief among these are irregular and hastily swallowed meals, physical exercise too soon after food, overeating, or too long intervals without a meal. The symptoms complained of are mostly discomfort and fullness in the epigastrium after a meal and loss of appetite. There is probably a resultant gastritis, and a simple readjustment of the daily routine produces rapid improvement. Such forms of indigestion have been termed by Ryle *habit dyspepsia*.

NERVOUS DYSPEPSIA

At the present time there is a tendency to discourage the employment of the term *nervous dyspepsia* as a diagnosis. While it is true that such a diagnosis should be made with caution and only after a full consideration of the facts in each individual case, there are a large number of patients in whom dyspeptic symptoms can only be explained on the basis of abnormal emotional states. Gastric and intestinal motility depend on the proper functioning of a delicate nervous mechanism, and the same is true of the secretion of the digestive juices. Any factors which upset the nervous mechanism may produce symptoms referred to the gastro intestinal tract. So common a phrase as "sick with fear" illustrates the familiar fact that fear or anxiety may produce a sensation of nausea or even

actual vomiting. Similarly, emotions such as grief or acute anxiety commonly produce anorexia or nausea. Emotion may also disorganise the normal functioning of the intestine or bladder. While it is true that in most normal persons gastro-intestinal upsets due to emotions such as fear, grief, excitement or anxiety are of comparatively brief duration, there is certainly a well defined group of patients in whom these factors produce a more lasting effect.

Nervous dyspepsia is one of the most common manifestations of an anxiety state. Often in addition to gastro-intestinal symptoms there may be other complaints, such as palpitation, headaches, lassitude, lack of power of concentration, and insomnia. The symptoms are very variable both in duration and severity. Perhaps the most frequent complaint is flatulence and distension occurring soon after meals. Pain is unusual, though the patient often complains of abdominal discomfort and a sensation of weight in the epigastrium. Loss of appetite and sometimes nausea are frequent, but, unlike these symptoms in chronic gastritis, they are not specially prominent in the early morning. The anxiety element is usually very obvious and the patient may have already made up his mind that he has cancer. Often, however, he is not prepared to admit his fears to the doctor lest he should be thought to be neurotic. In such cases a thorough physical examination, followed by a barium meal, may often effect a remarkable cure.

Probably in all anxiety states the receptivity of the nervous system is increased and patients in this condition become aware of peristaltic movements in stomach and intestine, which in normal persons do not produce any sensations. In addition owing to the disordered nervous system, there is increased and abnormally vigorous peristalsis, often with considerable aerophagy. Sometimes the condition is aggravated by a great increase in the number of cigarettes smoked, or perhaps by the taking of excessive amounts of alcohol.

A knowledge of the patient's circumstances and environment is of great value. Financial and business worries leading to overwork and exhaustion are potent factors in the production of digestive upsets. The same is true, and even more so, in the case of domestic unhappiness. Marital infelicity, broken-off engagements, unfaithfulness of husband or wife, aged and crotchety parents, illness or deaths of children or loved ones are among the more frequent causes of anxiety states, in which nervous dyspepsia may be the most prominent feature. Perpetual quarrels at meals, so common among ill-assorted couples, are particularly detrimental to the digestion. Alvarez,

in his stimulating book on "Nervous Indigestion," quotes the very true words from the seventeenth chapter of Proverbs "Better is a dry morsel and quietness therewith than a house full of feasting with strife"

It must not be forgotten that patients with nervous dyspepsia are liable, especially if the condition is of long duration, to develop an organic lesion particularly a duodenal ulcer. This is specially likely if the patient is of the type who has a rather small hyperactive stomach and a raised gastric acidity. Whenever a patient with dyspeptic symptoms thought to be of nervous origin fails to react to treatment a full investigation should be insisted upon, including an X ray examination a test meal and examination of fecal specimens for occult blood. If these are all negative they provide additional reassurance not only to the patient but to his medical adviser.

Some patients with nervous dyspepsia are very prone to imagine that certain articles of diet "disagree with them." In consequence they may progressively limit their diet until they suffer from chronic inanition. If they can be persuaded to take a liberal and nutritious diet their health improves.

The first essential in the treatment of a patient with nervous dyspepsia is to acquire his confidence. On no account should it be suggested that his symptoms are imaginary or exaggerated. In dealing with educated and intelligent patients it is well to stress the fact that the normal movements of the stomach and intestine, and also the secretion of the digestive juices, are all dependent on an adequate nervous control. When the central nervous system is in a state of increased excitability as a result of anxiety, emotion, or overwork and stress, this must react on the nervous mechanism controlling digestion. If aerophagy is troublesome, as is so often the case, the mechanism by which it occurs can be explained and the patient is instructed how to avoid swallowing air by restraining his attempts at eructation and keeping his mouth open after meals with a cork. If the dyspepsia is being aggravated by incorrect habits of feeding or by dental sepsis, steps should be taken to readjust the patient's routine and he should be made to consult his dental surgeon. Sometimes the patient may already be taking unnecessary purgatives under the impression that they will "clear his system" or "stimulate his liver." If this is so he should be advised to avoid purgative drugs and take small doses of paraffin or petrolagar if necessary.

Dyspepsia associated with constipation occurs frequently among young women who work in offices. It is often due to getting up late, a hastily swallowed breakfast, and a rush to

the station. There is no time for defaecation, and as a result a chronic constipation develops, which is relieved periodically by a powerful purgative.

In most cases of nervous dyspepsia, reassurance and explanation, combined with rest and a holiday, are of greater value than dieting and drugs. Very often the patient may already have limited the diet to a totally unnecessary degree, and if this is discontinued and a plain, ordinary diet instituted, there will be an improvement in the general health. Sometimes patients benefit by taking rather small dry meals and by avoiding large amounts of liquids at meals. Excessive consumption of tea or coffee should be forbidden. As regards drugs, a bromide mixture with a little arsenic is often of value in dulling the keen edge of the patient's anxieties. Although nervous dyspepsia is by no means always associated with a high gastric acidity, alkaline mixtures are often effective in alleviating the symptoms. *Magnesia emulsion* with the addition of 5 minims of tincture of belladonna is worth a trial. The belladonna probably renders peristalsis less vigorous and prevents pylorospasm.

Nervous dyspepsia is an extremely common condition, probably considerably more common than duodenal ulcer or cholecystitis.

In patients suffering from anxiety neuroses a vicious circle is often established. Dyspeptic symptoms arise as a result of their anxieties and the digestive disturbance produces still further anxiety. Unfortunately the difficulties, environmental, domestic, or financial, which induce the original anxiety state, are usually beyond the control of the medical attendant but it is often possible to alleviate the condition by eradicating from the patient's mind the idea that he is suffering from some serious organic ailment.

Anorexia Nervosa—It is a well recognised fact that after even a short period of fasting there is a loss of appetite, which may sometimes become so complete that the patient loathes even the sight or thought of food. This condition is described as *anorexia nervosa* and occurs chiefly in young women. Although the patients may be extremely emaciated and cachectic, they nevertheless often lead most active and even restless lives and maintain that they are perfectly fit.

The origin of the anorexia is nearly always psychogenic and not infrequently it follows domestic upsets such as a broken-off engagement, or it may represent a means of escape from a difficult situation. Occasionally the anorexia follows on a deliberate reduction of diet owing to fears of obesity. Some

times, especially in children refusal to eat starts as an attempt to become a centre of interest. As an example of this condition may be quoted a case who was in Guy's Hospital under the care of Sir Arthur Hurst some years ago. The patient was a girl of about seventeen, who for many months had been limiting her diet until she was eating practically nothing. On careful questioning it was found that other girls at her school called her a "fat German," as her name was somewhat foreign. Her anorexia had developed in an attempt to diminish her weight, as her name she could not alter. When the position was explained to her she readily consented to eat an ordinary diet and returned to her normal weight and health.

In addition to the anorexia these patients often have amenorrhoea which, in conjunction with the emaciation, sometimes has led to a diagnosis of Simmonds' disease (*vide* p 288). Injections of hormones, however, are quite useless and the symptoms disappear if the patient can regain her normal nutrition by returning to a normal diet.

Anorexia nervosa is a serious condition as it renders the patient an easy victim to intercurrent infection. Patients cannot be satisfactorily treated in their own homes, as unless there is strict supervision it is impossible to ensure that adequate meals are eaten. They should be kept in bed in a nursing home or institution and, at any rate to begin with, the doctor must supervise the eating of their meals. A simple explanation to the patient that the illness is due to lack of food is of more immediate value than elaborate psychotherapy. A full mixed diet should be given from the outset, and in addition the patient should be made to take large amounts of glucose. If handled with firmness, patience and tact the patient's resistance to taking food is usually overcome quite quickly, weight increases and health is regained.

DISEASES OF THE INTESTINES

PHYSIOLOGY OF THE INTESTINAL MOVEMENTS

The small intestine consists of the duodenum, jejunum, and ileum, and is about 22 ft in length, while the large intestine or colon is about 6 ft long. There is a marked contrast between the types of peristalsis seen in the small intestine and in the colon. In the former the food passes rapidly through the coils of intestine and reaches the ileo caecal valve in about three and a half hours, while the passage of food residue through the

colon may take twenty four hours or more before the rectum is reached

The food as it leaves the stomach passes very rapidly through the duodenum and jejunum and gradually slows up in its course through the lower portion of the ileum. In addition to peristaltic waves which sweep the food along the intestine, segmentation movements take place, consisting of localised contractions in the intestine, which help to mix food and digestive juices and bring them in contact with the mucous membrane of the intestinal wall, thereby facilitating processes of absorption.

Our knowledge of the intestinal movements has been obtained almost entirely from the radiological studies of Cannon, Hurst and others. If the course of a barium meal be traced through the intestines it is found to reach the ileo-cæcal valve in about three and a half hours. At this point the barium is held up for a considerable time until the ileo-cæcal sphincter relaxes and peristaltic movements in the terminal coils of the ileum drive the meal through into the cæcum. The passage of the barium into the colon is markedly accelerated during and shortly after the taking of food into the stomach. Thus it would appear that peristalsis in the lower coils of the ileum occurs reflexly as the result of gastric distension, the so-called *gastro-ileal reflex*. Although at an X ray examination movements of the small intestine are invariably observed, it is extremely rare to see any peristalsis in the large intestine, in spite of the fact that the contents of the colon obviously must move towards the rectum. The explanation of this lies in the fact that colonic peristalsis occurs only at infrequent intervals, probably not more than three or four times a day, and it is therefore unlikely to be observed during the relatively short period in which an individual is being examined under the fluorocent screen. The colonic movements consist of what has been termed 'mass peristalsis'—the contents of a whole section of the colon move bodily onwards without segmentation through a considerable length of the colon within a period of a few seconds, so that within less than a minute the distribution of a barium meal in the colon may be completely altered. This process of mass peristalsis carries the food residue or faeces around the colon until it reaches the pelvic rectal flexure which is a more or less acute angle at the junction of the rectum and pelvic colon. Just as the taking of food produces a reflex stimulation of the movements of the ileum so it tends to produce mass peristalsis in the colon, the *gastro-colic reflex*.

The act of defæcation is normally initiated by the passage of accumulated faecal material from the loop of pelvic colon through the pelvi-rectal flexure into the rectum. This is commonly brought about as a reflex result of taking a meal, particularly if the latter be hot or bulky. The distension of the rectum immediately produces a sensation that defæcation is necessary, and the act of defæcation itself occurs partly as the result of reflex contractions in the colon and partly from voluntary relaxation of the anal sphincter, with an increase in the abdominal pressure from voluntary contraction of the abdominal muscles and diaphragm. During defæcation peristalsis occurs throughout the colon, and all its contents, at any rate from the splenic flexure downwards, are driven into the rectum and expelled through the relaxed anal sphincter. The mucous membrane of the rectum itself is insensitive to tactile stimulation, and the "call to defæcation" is the result of stretching of the musculo fibres of the rectal wall, induced by the ontry of faeces into the rectum from the pelvic colon. A similar sensation may be produced by increasing the intra-rectal pressure by blowing up a rubber bag placed in its lumen. In normal individuals the rectum is empty both after defæcation and until just before the act of defæcation.

CONSTIPATION

What has been said above in reference to the mechanism of defæcation gives us the explanation of that form of constipation, termed by Hurst *dyschezia*, which is that most commonly met with in practice. By *dyschezia* is meant an inability to defæcate completely; even in the most severe cases of this type of constipation there is no delay in the passage of the faeces through the colon until the pelvic colon is reached. The great majority of cases arise from faulty habits regarding defæcation. As has been pointed out, the normal stimulus to defæcation is distension of the rectum, and it must be the personal experience of all that if the "call to defæcation" be neglected for any reason, the sense of discomfort in the neighbourhood of the rectum passes off in the course of quite a short time, and the individual no longer feels any need to empty his bowels. In all probability the feeling again arises after the next meal owing to the rectum becoming further distended, as the result of additional faeces entering it from the pelvic colon. Most cases of *dyschezia* arise from habitual neglect to respond to the normal stimulus; this neglect is the result most commonly of laziness or preoccupation with other

netivities, and is specially liable to occur in childhood. If this habitual neglect is continued over a prolonged period the warning that defecation is indicated becomes progressively diminished, until in well-established cases of dyschezia it is possible for the rectum to be continuously distended with faeces, without the production of any sensation of discomfort. Only too often after the constipation has lasted for some days the patient takes a powerful purgative thereby hurrying the passage of the faeces through the parts of the colon in which there is no delay into the pelvic colon and rectum, where it produces so considerable a rise in tension that defecation is initiated. The bowels having been thoroughly emptied by a purge the whole baneful process is repeated and soon the patient gives up all effort to effect an evacuation unless a purge has been taken. Eventually constant stretching of the muscular wall of the rectum and pelvic colon by retained faeces produces a condition of atony and weakness in the muscle fibres themselves which render recovery from the condition difficult.

Dyschezia as described above is specially liable to occur in young women who go out to work in factories or offices every day. Going late to bed, with resulting disinclination to get up in the morning, too often means a hurried and inadequate breakfast and no time to visit the water closet before catching train or bus. If a call to defecation occurs later it is again often neglected as the result of false modesty or a disinclination to leave work. Another potent cause of dyschezia is an inadequate supply of sanitary accommodation in schools or institutions.

For the efficient performance of the act of defecation there is needed not only the stimulus conveyed by a distended rectum but a forcible contraction of the muscles which raise the intra abdominal pressure during evacuation. Consequently, even though there is no delay in the passage of faeces through the colon, dyschezia may result from weakness of the abdominal muscles, the diaphragm, or the muscles of the pelvic floor, all of which come into play during normal defecation. A sedentary life without any exercise will lead to flabby abdominal muscles, similarly, overstretching of the abdominal wall as a result of pregnancies or damage to the pelvic floor during labour frequently leads to dyschezia.

Another less frequent cause of dyschezia is found in local conditions which interfere with the emptying of the rectum. Fissures or inflamed piles by their pain tend to produce spasm of the sphincter and inability to defecate. Inflammatory conditions of the female generative organs may produce difficulty

in defæcation, while the lumen of the rectal or anal canal may obviously be narrowed by such pathological conditions as growths or strictures

Although the great majority of the cases of constipation commonly met with in practice fall into the class of dyschezia, constipation may also occur in which the passage of the fæces is unduly slow throughout the length of the colon. This is known as colic constipation or colonic stasis and is due to a variety of causes. It may occur as the result of weakness in the muscles of the colonic wall, which are incapable of exerting sufficient force to produce mass peristalsis. This condition is liable to occur in the subjects of chronic diseases and in old age. In other cases there may be spasm of localised areas in the colon leading to what has been termed *spastic colitis*. This is probably the explanation of the constipation associated with lead-poisoning and sometimes with the excessive use of tobacco. Colic constipation may also occur as the result of pathological conditions in or around the colon, such as growths, strictures due to cicatrization of ulcers, diverticulitis, or chronic intussusception. In cases of functional nervous disorders, such as neurasthenia and depressive states, constipation is often very troublesome, owing to diminished reflex activity.

There remains a third type of constipation due to a diet which is inadequate in amount or contains too little unabsorbable residue. The amount of food actually consumed may be unduly restricted as the result of poverty, deficient appetite, or functional nervous conditions, or it may contain too small an amount of fruit and green vegetables. The passage of the fæces in such cases is not as a rule delayed until the pelvic colon is reached, but owing to inadequate bulk the normal stimulus to defæcation is not produced.

There is a wide variation in normal individuals as regards defæcation. Although a movement of the bowels once every twenty-four hours is usually regarded as normal, there are many people in perfect health who defæcate only once in forty-eight hours, on the other hand, two or even three motions a day may be simply the result of habit rather than of deranged function. A diagnosis of dyschezia can usually be made on the strength of the history and the constant presence of fæces in the rectum on digital examination. In cases of colonic stasis, an accurate diagnosis usually necessitates the use of X-rays.

Symptoms—In uncomplicated cases of dyschezia it is very doubtful whether there is any real absorption of toxins from the retention of fæces in the rectum and pelvic colon. Probably the symptoms complained of are largely the result of auto-

suggestion based on advertisements of purgatives. Discomfort is more likely to follow the taking of powerful purgatives both from the colic they produce and possibly as the result of toxic absorption from liquid feces in the colon.

While there can be no doubt that constipation frequently aggravates other diseases such as migraine, epilepsy, asthma or nephritis and may in itself produce lassitude, headache, vertigo, anorexia and many other symptoms, there is no evidence that it is really responsible for the syndrome formerly described as chronic intestinal stasis.

Treatment of Constipation.—Before attempting to treat a patient with constipation it is essential to arrive at a definite diagnosis of the type of constipation present. Very often a readjustment of the diet with alteration of the daily habits as regards exercise may suffice. In long standing cases of dyschezia the use of enemata for a considerable period may be necessary, but it is important that the patient should make a real effort to defæcate without artificial aid. The faulty conditions of life which have led to the condition must be explained to the patient who often by the time medical advice is sought is fully persuaded that it is quite impossible for a movement of the bowels to occur without drugs. The volume of the enemata should gradually be reduced and in most cases after a few weeks of treatment it is found that they can be dispensed with completely. Alternatively small glycerine enemata may be used (glycerine ᠑᠒ to ᠑᠔ diluted with an equal volume of water). As it is easier to evacuate semi-solid feces than the hard scybala common in constipation, liquid paraffin should be taken. In most mild cases this is effective alone if taken properly; not infrequently patients say that they cannot take paraffin as it runs through them; on careful inquiry it will usually be discovered that they are taking a single large dose once in the day. As the action of paraffin is purely mechanical it is important to take it at least twice and preferably three daily shortly after the main meals as it then is able to get thoroughly mixed with the food throughout the intestinal canal. In order to increase the bulk of the feces a mucilage such as agar agar can be given in conjunction with paraffin. In some very severe cases of dyschezia the muscle of the rectal wall seems to have completely lost its tone and evacuation by means of enemata may have to be persisted in almost indefinitely.

In the case of dyschezia due to weakened abdominal muscles efforts must be made to increase their tone by exercises. The assumption of a squatting position during the act of defæcation

may also be employed in such cases as the pressure of the thighs on the abdomen may help to raise the intra abdominal pressure

When constipation is proved to be the result of deficient power or tone in the colon itself, abdominal massage may be useful. If it is due to organic pathological conditions in the colon itself, these must be dealt with.

Although purgative drugs are usually unnecessary for any length of time in constipation, it is often desirable at the beginning of treatment to clear out the intestine. The combination of an enema and a dose of castor oil will usually be efficacious. If purgatives have to be employed over a prolonged period, and paraffin is not satisfactory, an infusion of senna pods may be tried, five to eight pods are soaked for twenty four hours in cold water, which is then drunk. The dose can readily be regulated by varying the number of pods.

CHRONIC DIARRHŒA

When a patient complains of diarrhœa lasting for more than a few days the medical attendant must insist upon seeing the stools. Naked eye examination may reveal obvious blood, mucus or pus which necessitates an immediate investigation with the sigmoidoscope and X ray, if the danger of overlooking such serious conditions as a growth of the colon or rectum is to be avoided.

Chronic diarrhœa may be due to various causes —

- 1 Defective digestive secretions (a) gastrogenous diarrhœa, (b) fatty diarrhœa in pancreatic insufficiency (*vide p 477*)
- 2 Organic disease in the intestine tuberculous ulceration ulcerative colitis, dysentery, growths
- 3 Toxic or infective conditions uræmia septicæmia especially streptococcal, Graves disease
- 4 Nervous diarrhœa

The diarrhœa associated with the conditions listed under (2) and (3) above is merely a symptom and needs no discussion here. Gastrogenous and nervous diarrhœa are not uncommon.

Gastrogenous Diarrhœa—Patients with achlorhydria or hypochlorhydria may suffer from a troublesome chronic diarrhœa. The stools are loose, but contain no blood or mucus. The symptoms are as a rule most marked in the mornings. The diarrhœa may be due to impaired gastric digestion and rapid emptying of the stomach. Treatment with hydrochloric acid is usually strikingly effective. One drachm of acid

hydrochlor. dil (B P) should be taken in a glass of lemon or orangeade with each meal

Nervous Diarrhœa—The satisfactory functioning of the intestinal tract depends on the nervous system. Worry, anxiety, and fear produce over activity of the gastro colic reflex and increased intestinal peristalsis, which, though usually a purely transient phenomenon, may sometimes last for long periods, especially in anxiety neuroses. Often this type of diarrhœa is *henteric*, defecation occurring immediately after every meal. The symptoms are little affected by diet. In such patients the following mixture is often helpful: tinct. belladonnæ ℥v, tinct. hyoseyami ℥xx, aqua menth. pip. ad ʒss tds po. Hot drinks are best avoided, but the general nervous condition of the patient needs attention. Reassurance and a bromide mixture are required. Codeine ($\frac{1}{2}$ gr. pill) is often effective and is convenient to carry.

Pseudo-diarrhœa—Diarrhœa may occur in cases of what is really constipation. Thus with growths of the colon there may be an accumulation of feces above the stricture, although a certain amount of fluid feces, often mixed with blood and mucus, are passed at frequent intervals. Similarly intussusception may be characterised by the frequent passage of blood, although obstruction of the bowel is present. Sometimes, even in cases of dyschezia, there may be frequent motions consisting of a few small scybala, and the patient may describe the condition as one of diarrhœa. The error is easily discovered by finding masses of feces in the rectum.

Undoubtedly some individuals are more liable to attacks of diarrhœa than others owing to some inherent hyperirritability of the colon. This is often the case after amoebic dysentery. Even many years after the last acute attack the slightest dietetic indiscretion may lead to an attack of diarrhœa. Persons with a tendency to diarrhœa should avoid residence in a tropical climate.

Intestinal Carbohydrate Dyspepsia—In this condition there is a deficiency of diastase in the intestinal juices, which results in an imperfect digestion of starch. Fermentation occurs in the colon with the production of much carbon dioxide.

Symptoms—The patient's main complaints are a feeling of abdominal distension and discomfort, borborygmi, and the passage of much flatus. The symptoms are often much aggravated at night waking the patient and causing insomnia. Pain is unusual, but sometimes there is diarrhœa and colic due to a secondary colospasm. Much relief is experienced after the passage of flatus.

Treatment—There is no difficulty in the digestion of sugar, and therefore no need for this to be restricted. Free starch as in flour and bread is also usually well digested. The starch in root vegetables, rice and potatoes is however, enclosed in cellulose envelopes and it is chiefly in this form that it reaches the cæcum when the digestion of starch in the small intestine is defective. In cases of intestinal carbohydrate dyspepsia it is therefore important to exclude completely from the diet potatoes, rice and root vegetables. This alone is often sufficient to relieve the symptoms. In addition to dietetic restrictions diastase tablets (5 gr tds) may be taken and also 1 to 2 drachms of finely powdered charcoal thrice daily. As a result of treatment the excess of starch in the stools rapidly disappears and the dietetic restrictions can be gradually relaxed. Potatoes however should be avoided permanently.

INTUSSUSCEPTION

In this condition a portion of the intestine usually the ileum near the ileo cæcal valve is invaginated into the lumen of the bowel immediately below. Infants are far more often affected than adults and in the former the symptoms are acute whereas in the latter they are usually chronic.

Acute Intussusception in Infants—Male children are mainly affected and the disease is most common during the first year of life. The victims of acute intussusception are usually healthy well nourished infants but slight gastro intestinal upsets often immediately precede the onset of intussusception.

Symptoms—The illness begins with colicky abdominal pain which causes the child to scream soon after the onset vomiting occurs but is seldom repeated. After the passage of one or two normal motions nothing but blood and mucus is passed. On palpation a sausage shaped tumour is often felt lying transversely across the abdomen with its concavity downwards. This consists of the intussuscepted gut and may ultimately extend round into the left iliac fossa. There is no rigidity except during attacks of pain but the abdomen may become distended. The pulse is rapid but the temperature remains subnormal. Unless the condition is relieved by operation death is almost certain.

Diagnosis—In infants the passage of pure blood or blood and mucus quite unmixed with faecal material and with no faecal odour is practically diagnostic of intussusception. The typical tumour can often be felt though occasionally an

anæsthetic is necessary to enable it to be recognised. The only conditions with which acute intussusception is likely to be confused are acute colitis or Hænoch's purpura which may indeed sometimes be complicated by intussusception, in these conditions, however, there is practically always a faecal odour in the stools even if there be no obvious faecal material. Moreover, in acute colitis the onset is likely to be more gradual than in intussusception.

Treatment—Immediate operation is necessary.

Chronic Intussusception—Intussusception also occurs in adults more commonly in males than in females, the condition is usually brought about by the presence of a growth either innocent or malignant which forms the apex of the invaginated gut. The symptoms point to an intermittent chronic obstruction often with blood and mucus in the faeces. Sometimes a palpable mass can be felt in the abdomen, this may vary in size from time to time and may disappear completely owing to the bowel becoming disinvaginated, only to recur at a later date. Owing to the obstruction colicky pains occur, and during the exacerbations there may be constipation and vomiting. Sometimes acute obstruction may supervene after a period of intermittent chronic obstruction. Often the condition is mistaken for a growth and the true diagnosis is not made until laparotomy is performed. Treatment consists in early operation at which the intussusception is reduced and a careful search made for a cause, such as a polypus or growth.

REGIONAL ENTERO COLITIS (*Crohn's Disease*)

Crohn described as *regional ileitis* a condition in which the terminal ileum is found to be thickened, oedematous and ulcerated. As the caecum and not infrequently the ascending colon are also involved. Hurst has suggested that the condition should be described as regional enterocolitis. The aetiology remains obscure but although histological examination is suggestive of tuberculosis tubercle bacilli have never been found in the lesions and the disease is probably inflammatory in origin and non-tuberculous. The lumen of the affected ileum is much narrowed and there is a variable degree of obstruction.

Symptoms are very variable. repeated attacks of colicky pain in the neighbourhood of the umbilicus or in the right iliac fossa. abdominal distension, tenderness in the right lower abdomen where sometimes a sausage shaped tumour is

palpable, slight pyrexia and polymorphonuclear leucocytosis, occasionally diarrhoea. Occult blood is nearly always present in the feces. There is a tendency in long standing cases for fistulae to form between loops of intestine. The symptoms are usually slowly progressive and a definite diagnosis is seldom made except on the X ray findings. After a barium meal repeated examinations of the terminal ileum are made at hourly intervals. Filling defects are seen in the terminal ileum, and the barium shows as a thin irregular linear shadow connecting the dilated coils of ileum to the caecum. This is known as the 'string sign' from its appearance.

Regional ileitis is likely to be mistaken for appendicitis, ileo caecal tuberculosis or growth of the caecum. The only effective treatment is excision of the whole of the diseased area.

APPENDICITIS

Full descriptions of acute appendicitis in all its aspects are available in textbooks of surgery and here it is proposed to deal only with the condition often described as chronic appendicitis or appendicular dyspepsia.

The symptoms attributed to chronic appendicitis are often vague, variable and of many months or even years' duration. Among the more common are abdominal discomfort or pain usually epigastric or around the umbilicus, flatulence, and nausea. Sometimes in addition to epigastric discomfort the patient may complain of short attacks of pain in the right iliac fossa. Deep palpation in this region elicits tenderness and sometimes also pain in the epigastrium. The pain differs from that of a peptic ulcer in having a less regular relationship to meals and it is seldom relieved by food or alkalis. It is often aggravated by exercise.

A diagnosis of chronic appendicitis is never justifiable except after a thorough investigation to exclude other conditions such as an ulcer or cholecystitis. Moreover it is essential to confirm the diagnosis by X ray examination. In about 80 per cent of cases it is possible to visualise the appendix, either with a barium meal or enema, and to demonstrate tenderness which is strictly localised to the appendix. If the appendix fails to fill with barium, particularly if the X ray examination is repeated, this indicates a probability that its entry into the caecum is obstructed. Such findings in conjunction with suspicious symptoms suggests chronic appendicitis. Bastedo's test has been recommended as an adjunct to diagnosis.

This consists in inflating the coloo with air pumped into the rectum with an enema syringe. In cases of appendicitis inflation sometimes produces pain in the appendix region. More often however the general discomfort due to colonic distension effectually obscures any local pain.

During the last twenty years many victims have been sacrificed on the altar of chronic appendicitis. While it must be admitted that sometimes a complete cure is effected by appendicectomy only too often the patient's symptoms recur within a few months and may lead to further operations for adhesions. Ill judged appendicectomy is often the prelude to many years of chronic invalidism. On no account should operation ever be undertaken except after the most careful investigations and the patient's desire for operation should never be allowed to influence the decision.

It is important to realise that recurrent attacks of acute appendicitis are entirely different from chronic appendicitis and call for early appendicectomy.

DISEASES OF THE COLON

METHODS OF EXAMINATION

The Sigmoidoscope—The investigation and treatment of diseases of the coloo has been greatly facilitated in recent years by the more frequent employment of the sigmoidoscope. With this instrument it is possible to obtain a clear view of the lower 10 in. of the alimentary caoal and the practical value of this is obvious when it is remembered that this is the portion of the colon which is specially liable to be involved by growths and ulcerative colitis. For a sigmoidoscopic examination it is rarely necessary to give an anæsthetic either local or general and with reasonable care there is no danger of perforating the bowel. Moreover the procedure is merely uncomfortable. Unless the patient is extremely constipated no preparation with purgatives or enemata is required. The latter are liable to produce redness of the mucous membrane which may be mistaken for inflammation. The examination is made in the knee elbow position. Before any attempt is made to pass the instrument a rectal examination should always be made to exclude a growth low down in the rectum. The sigmoidoscope thoroughly lubricated with vaseline and warmed to body temperature is inserted gently through the anal canal when it has passed the anal sphincter it is pushed in the direction

of the sacrum through the first 2 in of the rectum. The introducer is then withdrawn and the further passage of the instrument is controlled by direct vision. It is most important not to push the instrument forward unless the lumen of the gut is clearly visible. At the upper end of the rectum, 4 in from the anal canal, the pelvic rectal flexure is clearly visible and the sigmoidoscope is manipulated around it into the pelvic colon. A carcinoma of the colon may be easily visible through the sigmoidoscope. It bleeds readily and will prevent further passage of the instrument. Swabs for bacteriological cultivation can be taken from ulcers through the lumen of the sigmoidoscope. A proctoscope is valuable for inspection of the rectum and anal canal.

X-ray Examination of the Colon—Examination of the colon following a barium meal is not often of great value, except as indicating the rate at which the opaque meal passes round the colon into the rectum. A barium enema is more valuable in the diagnosis of organic disease, particularly cancer or diverticulitis. A barium emulsion is run into the rectum under a low pressure, while the patient is observed under the fluorescent screen. In normal persons the opaque fluid passes readily round the colon as far as the cæcum within a few minutes. A partial stricture of the bowel, such as may result from a carcinoma, will often result in holding up the passage of the enema either indefinitely or for many minutes and this occurs long before symptoms of intestinal obstruction develop. In addition to the delay in the passage of the opaque salt there is sometimes a definite deformity or filling defect visible in the shadow cast by the affected region. In diverticulitis the barium may remain outlining the diverticula after the bulk of the enema has been voided.

Examination of the Fæces—It is essential to insist on seeing the fæces, as this may reveal the presence of blood, mucus or pus. This can be confirmed by a microscopical and chemical examination.

CARCINOMA OF THE COLON

Malignant growths of the colon and rectum are fairly common and may occur at a relatively early age. The most frequent site for the disease is the rectum but in the colon itself the pelvic portion is most often affected, particularly the last few inches above the pelvic rectal flexure. The early diagnosis of cancer of the colon and rectum is of the utmost

importance, as the growths are often of relatively low malignancy and metastasis is slow

Symptoms—These are extremely variable and depend on the situation of the growth and the degree of obstruction which it produces

- 1 Sudden onset of acute intestinal obstruction This is likely to occur with growths of the pelvic colon which encircle the gut
- 2 An alteration in the bowel habits in a patient whose bowels previously have been regular This alteration may be constipation or diarrhoea or more commonly alternation of the two
- 3 Visible or occult blood in the faeces Visible blood is chiefly seen in carcinoma of the rectum or pelvic colon Occult blood in considerable amount is an almost invariable finding
- 4 Abdominal pain This may be absent but there are often attacks of colicky pain across the lower abdomen or more vague feelings of discomfort or distension The pain is definitely related to defaecation
- 5 Tenesmus is frequent with growths in or near the rectum
- 6 Loss of weight and cachexia only occur late, but sometimes there may be a persistent pyrexia
- 7 Haemorrhoids often develop as a result of a carcinoma of the rectum

Growths involving the caecum are less likely to produce obstructive symptoms than are those in the more distal portions of the colon This is due to the relatively liquid character of the contents of the caecum They may however give rise to considerable anaemia from long continued bleeding In such cases although there may be no visible blood in the faeces occult blood is present in large amounts and spectroscopic examination of the faeces shows well marked acid haematin absorption bands

The diarrhoea which is so frequent a feature of carcinoma of the rectum and sigmoid is a pseudo diarrhoea in which liquid faeces only usually containing much visible blood pus and mucus are able to pass the stricture produced by the growth Above this the colon is loaded with solid faecal material and is sometimes palpable in the left iliac fossa In such cases obstruction may become complete and the patient develop acute symptoms

Pain is a very variable feature Often it is slight and associated with defaecation but occasionally there may be

severe attacks which simulate biliary colic. Vomiting is uncommon except with definite obstruction.

On physical examination in the early stages little definite information is obtained, unless the growth be palpable on rectal examination. With involvement of the cæcum a mass may be palpable, but growths of the splenic flexure and the pelvic colon are usually too deeply seated to be felt. The rectum is usually found to be empty and ballooned.

Diagnosis—It is impossible to stress too strongly the importance of making a thorough digital examination of the rectum in every case of piles or where some irregularity of the bowels, whether constipation or diarrhoea, has lasted for more than a fortnight. If nothing be found on rectal examination, the patient must be persuaded to undergo the slight discomfort of a sigmoidoscopic examination. With the adoption of such a procedure as a routine, probably some 50 per cent. or more of growths of the colon would be diagnosed early. The stools must be carefully and repeatedly examined for visible or occult blood and a barium enema should also be carried out (*rule p. 435*). A "follow through" with a barium meal is less likely to be helpful, and if there is any clinical evidence of obstruction, such as constipation, distension or vomiting, the additional obstruction produced by barium may precipitate acute symptoms.

Other pathological conditions may closely simulate carcinoma of the colon. Most important of these is ulcerative colitis, in which case, however, the diagnosis at once becomes clear on sigmoidoscopic examination. Diverticulitis, chronic intussusception, regional enterocolitis and hypertrophic cæcal tuberculosis may all simulate carcinoma of the colon, but can usually be differentiated by the clinical history and radiological findings. Faecal impaction in the rectum, especially in elderly patients, may give rise to suspicion, but rectal examination reveals the true condition.

Treatment—Surgical removal of the growth at the earliest possible moment is obviously indicated, where the condition is not too advanced. Failing this, colostomy may give temporary relief.

POLYPOSIS OF THE COLON

Single polypi are comparatively common in the colon and rectum and may cause hæmorrhage or intussusception. They are also liable to become carcinomatous. There is, however, a rare condition, often familial, in which there are multiple



PLATE 20—Polyposis of the Colon shown after Injection of Barium and Air
(From Plate 13 of A. Marxer)

polypi throughout the colon. Ulceration and hæmorrhage occur and the stools resemble those of ulcerative colitis. Some of the polypi almost invariably become malignant and this usually occurs in early adult life. Diagnosis is easy on sigmoidoscopic examination, and a hæmorrhoidoma will show up polypi beyond the reach of the sigmoidoscope as translucent areas (*vide* Plate 20). Bleeding may be considerable and the patient becomes severely anæmic. The outlook as regards development of carcinoma is so bad that colectomy should be advised. Polypi within reach of the sigmoidoscope must be destroyed by diathermy, and the patient should be sigmoidoscoped at six monthly intervals to detect early recurrence of polypi. Polyposis also occurs in chronic ulcerative colitis.

ULCERATIVE COLITIS

Ulceration of the colon may occur in toxæmic conditions, particularly in uræmia and it is a constant feature of both amœbio and bacillary dysentery (*vide* pp 182 and 185). The term ulcerative colitis is, however, applied to a well-defined clinical condition in which the colon is inflamed and ulcerated.

Ætiology and Pathology.—In spite of the immenso amount of energy which has been expended on the study of ulcerative colitis in recent years there is no real agreement as to its nature and ætiology. Various organisms, such as dysentery bacilli and Barger's diplococcus, have been accused of playing a causal role, but the evidence in favour of such theories is far from convincing, although sometimes the serum of patients with ulcerative colitis agglutinates dysenteric bacilli. Unlike dysentery, the disease is not infectious. It may well be argued that the ulceration of the colon may be due to the excretion of toxins into the colon rather than to a direct infection of its lining. The importance of psychological factors has been emphasised in the ætiology of ulcerative colitis. The disease is prone to occur in psychologically abnormal people under *emotional stress* and *relapses not infrequently follow psychical trauma*. It is undoubtedly true that mucous membranous colitis (*vide* p 441) is invariably associated with abnormal types of personality, but these cases rarely if ever develop ulcerative colitis. Most gastro intestinal diseases are liable to be aggravated by worry and anxiety, but it is difficult to regard them as primarily due to an abnormal psychological state.

Our knowledge of the pathology of the disease has been advanced in recent years by the use of the sigmoidoscope and



PLATE 20—Polyposis of the Colon shown after Injection of Barium and Air
(From Plate by O. A. Marxer)



PLATE 1.—1a) Larva of *L. (L.)* *larva*. The upper plate shows the larva when filled with barium
contrast. 1b) Larva when the larva has been partially evacuated. (Larva by O. A. Marver)

the X ray Whereas in the past we were only familiar with the advanced changes seen at autopsy, it is now possible to obtain a direct view through the sigmoidoscope of the mucous membrane of the rectum and lower portion of the pelvic colon as they occur in the early stages of the disease and during the process of healing Before obvious ulcers have formed or after they have healed the mucous lining of the colon instead of being shiny and moist appears velvety and granular and bleeds readily even with the gentle passage of the sigmoidoscope This condition which is similar to that in acute bacillary dysentery, is a diffuse one and may affect the whole of the visible mucous membrane As the disease progresses necrosis occurs and superficial ulcers are formed which in severe cases become so numerous that practically no mucous membrane remains In the more chronic cases the submucosa is invaded by a diffuse fibrosis, which eventually reduces the colon to a relatively narrow tube, which when visualised with a barium enema shows a complete lack of the normal haustration Such a colon with its lack of distensibility and its relatively narrow diameter is incapable of storing its contents, thus accounting for the persistent and intractable diarrhoea (*vide* Plate 21)

In the more chronic types of ulcerative colitis fibrous strictures may occur and sometimes polypoid adenomata develop, which occasionally undergo carcinomatous changes Perforation is extremely uncommon The part of the colon mainly affected is the rectum and pelvic colon but often the whole organ from the caecum to the rectum may be involved

Symptoms—Even when the onset is apparently acute, careful inquiry often shows that the patient has had at times slight symptoms such as hæmorrhage Usually the onset is gradual with diarrhoea as the main symptom At first the stools are loose, but blood and mucus appear early As secondary infection of the ulcers occurs pus in the stools becomes very obvious Faecal material is nearly always present in contrast to the stools of acute bacillary dysentery There is sometimes tenesmus and colicky pain especially immediately before defecation but severe abdominal pain is unusual The general condition of the patient is very variable and probably depends on the extent of involvement of the colon by the ulcerative process When the colon is widely involved, fever and tachycardia are often prominent features and the patient's general condition is obviously bad Even apart from severe hæmorrhage a profound secondary anaemia may develop Remissions and relapses are frequent, and it is doubtful

whether any patient can be said with certainty to be completely and permanently cured. Fistula in ano and anal fissures are distressing complications.

Differential Diagnosis—Carcinoma coli may produce stools indistinguishable from those of ulcerative colitis. Fortunately sigmoidoscopy rarely leaves the diagnosis in doubt for in ulcerative colitis the rectum and lower portion of the pelvic colon are almost invariably affected and if these portions are seen to be normal in a patient who is passing blood and mucus it is almost certain that there is a growth beyond the reach of the sigmoidoscope. Carcinomata of the rectum and pelvic rectal flexure are readily visible through the instrument. In amoebic dysentery the ulcers are deeper though less extensive and their edges more undermined.

Treatment—In few diseases is there so great a divergence of views as to treatment. Surgery medicated colon washouts anti dysenteric serum intestinal antiseptics vaccines sulphonamides vitamins strange diets such as apples all have their advocates. There are however two outstanding facts first that the earlier treatment is begun the better secondly that prolonged rest in bed and a high calorie diet are of undoubted value.

Diet—This should be liberal as the disease lasts for many months and it is important to maintain the nutrition of the patient. Vegetables and fruits which contain much non absorbable cellulose must be forbidden but fruit juice is desirable. Finely powdered animal charcoal in doses of 2 drachms or kaolin in $\frac{1}{2}$ oz. doses often helps to reduce distension and relieves discomfort from flatulence.

Colon Washouts—These are undesirable in acute cases and even in the more chronic types their value is doubtful. Warm normal saline is preferable to the solutions of tannic acid (1 gr. to 1 oz.) which are often employed.

More valuable than washouts are rectal injections of bismuth subgallate (dermatol) particularly where the rectum and lower pelvic colon is mainly involved. This drug is given in a mucilage made of coreine or isogel flakes (1 drachm of coreine in 4 oz. of water). 4 gr. of dermatol are added to each ounce of the mucilage and from 4 to 8 oz. of the emulsion are injected through a soft rubber catheter into the rectum where it is retained if possible all night. If nocturnal diarrhoea is troublesome 5 to 15 minims of tinct. opii may be added to the rectal injection or $\frac{1}{2}$ to 1 gr. of codeine may be given by mouth.

Anti dysenteric Serum—The value of this is doubtful but

it should be tried if the patient's serum agglutinates dysenteric bacilli. It is best given intramuscularly in ten daily doses of 10 c.c. of concentrated polyvalent serum.

Blood Transfusion—This is often of the greatest value, even when the patient is not severely anæmic. It probably acts by improving the resistance of the patient. Several transfusions of half a pint should be given on alternate days. Large doses of iron should also be given.

Surgery—Ileostomy is undoubtedly sometimes a life saving operation, particularly in acute cases with grave toxæmia. Appendicostomy and cæcostomy are now seldom performed. Following ileostomy some patients put on weight and the colon may even appear to heal. Colectomy has been successfully performed following ileostomy.

Prognosis—Unfavourable features are a persistently rapid pulse rate, widespread involvement of the colon, particularly of the cæcum and ascending colon or the presence of a stricture. The X-ray appearances are of great value. If the colon is small and completely tubular with no haustrations in any portion, no lasting improvement can be expected. The mortality in hospital is usually about 20 per cent, but if the patients are traced for some years it is considerably higher.

MUCO MEMBRANOUS COLITIS

Although the term colitis ought theoretically to be reserved for definitely inflammatory lesions of the colon, the name mucous colitis or muco membranous colitis has long been applied to a definite clinical condition characterised by obstinate constipation with mucus in the stools, although there is no inflammatory process comparable to that found in ulcerative colitis.

Mucous colitis is far more frequently seen in females than in males, and usually occurs in early middle life. Its victims are found among the rich rather than the poor, and in addition to their abdominal symptoms there is always a marked neurotic element. In the more severe and long standing cases the intestinal functions acquire an almost complete monopoly of the patient's thoughts and activities so much so that the character of their fæces becomes the main interest in life.

The characteristic symptoms of muco membranous colitis are constipation, the passage of mucus in the stools, and sometimes abdominal pain. The mucus may be excreted in unformed masses, but more frequently it occurs in the form of long strips,

somewhat suggestive of a tape worm. In severe cases there are complete casts of the colon which may be many inches in length. Microscopical examination of the mucus shows the presence in it of a few desquamated epithelial cells, but no pus cells. The faeces themselves are hard and scybalous unless the patient has taken violent purges, which may induce a transient attack of diarrhoea. The mucus is secreted by the glands of the colonic mucous membrane, under the combined influence of a hyperirritable nervous system and an obstinate constipation. Owing to the unfortunate mental attitude of the patient, the symptoms are grossly exaggerated and the passage of mucus causes the most intense mental agitation even though it may be accompanied by no other symptoms. Not infrequently there is in addition a spastic condition of the colon, which may often be felt on palpation to be firmly contracted. Such spasticity is often the cause of abdominal pain, which is aggravated by the taking of powerful purges. The most frequent site for pain is down the left side of the abdomen and in the left iliac fossa. Sigmoidoscopic examination shows a normal mucous membrane, but spasm of the circular muscle of the gut throws the mucous membrane into folds and tends to obliterate the lumen. In chronic cases where powerful purgatives have been employed there may be some congestion and slight bleeding. In addition to the mucus in the stools, there is occasionally the passage of intestinal "sand," consisting of reddish brown granules of the insoluble calcium soaps of palmitic and stearic acids.

The treatment of severe cases of mucous membranous colitis is one of the most trying tasks that beset the medical practitioner. Only too often the patient has already tried every conceivable line of treatment, and visits her doctor with an unalterable determination not to get well. In addition she is often regarded as a heroic martyr to her health by anxious relatives. In consequence the outlook is most unfavourable.

An attempt must be made to deal with the constipation, and at the beginning of treatment it is important to get the bowels completely emptied, an object which is best attained by the combined use of castor oil and enemata. Subsequently copious doses of liquid paraffin should prevent a fresh accumulation of faeces, and in addition rectal injections of warm olive oil may be given at night and retained till the morning. Where the constipation can be shown to be due to stasis in the upper part of the colon, the action of the paraffin may be reinforced by taking an infusion of senna pods, but all more powerful purgatives must be absolutely prohibited.

As the colon is abnormally irritable the diet should consist of foods which leave little residue, and uncooked green vegetables or fruits with skins or pips must be avoided. The inclusion of coarse articles of food such as bran which act as a stimulant to the peristalsis of a normal intestine is likely to produce an increase in the secretion of mucus.

When there is spasticity of the colon a useful prescription is tinct belladonna ℥v, tinct hyoscyami ℥xx, aq menth pip ad ʒss tds po. The belladonna diminishes the intestinal spasm. Smoking should be forbidden owing to its liability to produce spasm. Vaccines prepared from cultivation of the faeces are of no value, while all forms of operation such as colopexy, short circuit or colectomy are disastrous.

Mucous colitis is treated by colon washouts at spas such as Plombières, Harrogate, and Buxton. On the whole it is best to avoid anything in the nature of regular enemata or colon washouts, as such treatment tends to make the patient concentrate her attention on her colon. Such successes as are obtained by spa treatment are probably due not so much to the special properties of the waters as to the regularity of the life and the expectation of cure on the part of the patient, which is fostered by the whole atmosphere of treatment.

Anything which will serve to distract the patient's attention from her complaint is of value. Unfortunately, most of those afflicted with the disease are blessed or perhaps cursed with sufficient money to relieve them of any need to earn a living. Plenty of open air and exercise are indicated, but care must be taken to avoid cold particularly upon the abdomen.

DIVERTICULITIS

Noted at autopsy and in X-ray examinations of the colon small diverticula are found in about 5 to 10 per cent of persons over middle age. These diverticula are most frequently encountered in the pelvic colon, though they may occur throughout its length. They are more common in the male sex, but there is little evidence that they are specially frequent in the obese. In many cases they appear to cause no symptoms and the condition has been termed by Spriggs *diverticulosis*. The exact mechanism by which diverticula are produced is uncertain, but they are probably due to some local pathological condition rather than to increased intracolonic pressure due to constipation.

If the openings of diverticula become narrow, faecal material may stagnate in the pouches and infection supervenes. This

gives rise to symptoms and the condition is then described as diverticulitis. The inflammatory changes lead to thickening of the affected area of the colon, which becomes adherent to surrounding structures. Sometimes perforation may occur with the formation of localised abscesses, or adhesions to the bladder may cause urinary symptoms or even a colovesical fistula.

Symptoms—Abdominal symptoms vary according as the inflammatory process is acute or chronic. In the acute form acute appendicitis may be simulated, except that the pain, tenderness and rigidity are in the left iliac fossa. As a rule the acute process subsides sometimes with the formation of an abscess. Acute perforation into the peritoneum is very rare.

In the more usual chronic types of diverticulitis the symptoms may occur intermittently for many years with exacerbations and remissions. Abdominal pain, chiefly in the left lower abdomen, is the most frequent complaint. It is often aggravated by defæcation. The bowels tend to be constipated and irregular, but diarrhoea is unusual. Visible blood in the stools is uncommon. Occult blood, however, particularly hæmatoporphyrin, is often present. Dysuria may indicate adhesion of the inflamed diverticula to the bladder. On physical examination there is usually tenderness in the left iliac fossa and sometimes a sausage-shaped tumour may be palpable. Occasionally intestinal obstruction develops, but this is usually gradual in onset. During the acute or subacute phases of the disease there is fever and a polymorphonuclear leucocytosis.

Localised abscesses may form large abdominal tumours and may burst into the bladder, vagina or colon.

Diagnosis—This can usually be settled by a barium enema which may demonstrate not only the diverticula filled with barium but also sometimes the presence of polyps and narrowing of the lumen of the gut. It is important to remember that the mere discovery of diverticula does not necessarily mean that the patient is suffering from diverticulitis. With carcinoma of the colon there is more likely to be diarrhoea or obvious blood and mucus in the stools, and a barium enema will show a localised filling defect. Moreover, in most cases of diverticulitis the long history makes a growth of the colon improbable.

Treatment—In severe cases with obstruction, colostomy or resection of the affected portion of colon may be required. In the more common milder forms of diverticulitis, a diet without much unabsorbable residue, plenty of paraffin, and saline colon washouts may relieve the symptoms. In addition,



PLATE 9 —Dysentery of Colon. The X rays were taken before and after treatment. (From Plate by O. A. Warner.)

a mixture containing tincture of belladonna ℥v and tincture of hyoscyamus ℥xxx may relieve spasm. A few ounces of warm liquid paraffin should be injected into the rectum and retained over night.

HIRSCHSPRUNG'S DISEASE

This interesting though rare condition consists of great dilatation and hypertrophy of the colon, particularly in its distal portions. It is also known as megacolon and idiopathic dilatation of the colon.

Hirschsprung's disease is usually congenital, but it sometimes is first discovered in adult life. Probably the condition is analogous to achalasia of the cardia (*vide p. 389*) being due to a failure of the anal sphincter to relax. This obstructs the evacuation of the colon, which consequently becomes enormously dilated and hypertrophied. Owing to irritation by retained feces the mucous lining of the colon may become ulcerated.

The symptoms are very variable. Sometimes in adults they may be few apart from some constipation and colonic flatulence. In early life they are likely to be more severe, intractable constipation, abdominal distension, malnutrition and sometimes obstruction. The enormous dilatation of the splenic flexure may push the diaphragm upwards and produce dyspnoea. Occasionally patients complain of severe attacks of colicky pain simulating obstructions, but as a rule these pass off spontaneously.

On examination the abdomen is distended and the outline of portions of the dilated colon is obvious. The diagnosis is readily confirmed by a barium enema. Between 6 and 8 pints of the emulsion are required to fill the dilated colon, as compared with about 2 pints for the normal colon.

Treatment—If the patient has been constipated for a long period and the rectum is filled with scybala, it may be necessary to give an anæsthetic and remove the contents manually or with a spoon. A wide bore tube must be manipulated into the colon and its contents thoroughly washed out. Once evacuated the colon must not be allowed to refill. This object can sometimes be attained by *duly dilatation of the anal sphincter* with a tapered bougie, which is kept in position for 15 minutes before attempts at defæcation. Often daily saline washouts are necessary. Lumbar sympathectomy rarely produces good results but spinal anæsthesia often relieves symptoms and the improvement persists for long periods.

Megacolon in adults often causes little disability and is consistent with continued good health and activity. In children the outlook is usually said to be unfavourable but often this is not the case.

VISCEROPTOSIS

During the last twenty years ideas as to the position of the normal stomach and intestines have been revolutionised by radiological investigations and it is now generally recognised that in many normal individuals, particularly those with elongated chests and a narrow epigastric angle the abdominal viscera may lie at a very much lower level in the abdomen when the patient is in the vertical position than was formerly thought to be consistent with health. The mere fact therefore that there is some degree of ptosis of the stomach or colon is not in itself a proof of disease. Moreover it is very doubtful whether symptoms so frequently ascribed to visceroptosis are really connected with the position of the abdominal viscera.

The abdominal viscera are maintained in position by the pressure exerted by the muscles of the abdominal wall and of the pelvic floor rather than as the result of tension upon the various peritoneal ligaments. Although it is usually assumed that loss of tone in the abdominal muscles lowers the intra-abdominal pressure and leads to ptosis it is nevertheless a fact that many individuals with unduly lax abdominal muscles show no radiological evidence of ptosis. It is now becoming widely realised that a diagnosis of visceroptosis was often made on quite insufficient grounds and included many patients suffering from nervous dyspepsia, mucous membranous colitis, anxiety neuroses and chronic abdominal invalidism.

In the past it has been customary to describe separately symptoms ascribed to the ptosis of individual organs. In actual fact when the abdominal viscera are unusually low in the abdomen not one single organ such as the stomach or colon is involved but to a greater or less extent all.

In a very limited number of conditions ptosis of an organ may produce definite symptoms.

1 **Gastroptosis**—As a general rule when the stomach is ptosed the second portion of the duodenum is also low and there is no obstruction to the evacuation of the gastric contents. Occasionally, however this portion of the duodenum which is retroperitoneal remains attached at a relatively high level in the abdomen although the pylorus and first portion of the duodenum are dropped. In such a case there is a sharp kink

at the junction of the first and second portions of the duodenum, which may produce an obstruction to the passage of the gastric contents. This is only the case when the patient is in the erect position. When recumbent the stomach lies at a higher level and the kinking disappears. If the patient is X rayed it can be seen that there is gastric stasis in the erect posture and definite gastric delay. Lying down the stomach empties in normal time. In these rather unusual cases the patient may complain of a sensation of weight and distension after meals, which is relieved by lying down, especially on the right side. Meals should be small and rather frequent and the patient should lie down for half an hour or more after meals. Surgical interference is unlikely to be successful but possibly an abdominal belt may help to relieve the symptoms.

2 Chronic Duodenal Ileus—The duodenum is sometimes constricted at the point where it is crossed by the mesentery and the mesenteric vessels. This produces a dilatation of the proximal part of the duodenum. The condition can be definitely diagnosed only by X ray examinations, but it may give rise to vague symptoms of right sided discomfort. Sometimes the duodenal stasis may be associated with a duodenal ulcer. The condition is often the result of a general enteroptosis, as the weight of the small intestine pulls on the mesentery and constricts the duodenum. Relief can often only be obtained by operation.

3 Nephroptosis—Although the kidneys are not part of the alimentary tract ptosis of these organs practically never occurs apart from a general visceroptosis and the subject of nephroptosis or movable kidney is best dealt with in this connection rather than under the heading of renal diseases. The ptosis is always more apparent on the right side owing to the close relationship between the right kidney and the hepatic flexure of the colon. In most cases there are no symptoms except those produced by suggestion on the part of an imprudent medical attendant, who tells the patient that the kidney is displaced. Occasionally there may be a dragging pain in the loins, with attacks of severe colic similar in type to those which occur as the result of a stone in the ureter. Such attacks which are termed *Dietl's crises*, are the result of a kinking of the ureter with partial obstruction of its lumen, and are usually due to the presence of an aberrant renal artery.

Apart from the conditions described above it is doubtful whether visceroptosis produces any symptoms. Those ascribed to the condition are nausea, anorexia, abdominal discomfort and pain, chronic constipation, the passage of mucus in the

stools, loss of weight, general malnutrition and ill health. Often in addition the patient suffers from insomnia, palpitation, and fatigue, physical and mental. Such patients are nearly always females and there is often evidence that even from childhood they have been under average in physique and stamina. Unmarried and childless women form the majority, and the domestic environment is often unsatisfactory.

Unfortunately a diagnosis of visceroptosis is usually welcomed by the patient, to whom it appears a satisfactory explanation of her numerous and manifold complaints. Moreover, it is an idea which it is very much easier to implant than to eradicate from the mind of the patient. It is therefore unwise ever to suggest to a patient that the viscera are dropped or displaced, except perhaps in cases of duodenal ileus or Diehl's crises, where the condition calls for surgery.

Ptosis of the colon does not produce kinking at the flexures and the constipation which is so often found in these patients is due to dyschezia and not to delay in the colon.

Occasionally the liver or spleen may be abnormally low, but few if any symptoms are produced except in the rare cases where there is torsion of the pedicle of the spleen.

Treatment—It is important to exclude organic disease by a thorough investigation, as a general condition of ill health may be produced by tuberculous infection, or the abdominal symptoms may be due to an atypical peptic ulcer. If all investigations prove negative it is essential that the medical attendant should not allow the patient to gain the impression that her symptoms are being regarded as imaginary. Such an idea will at once undermine her confidence in her doctor and lead to a lack of co-operation, which will render any attempt at treatment hopeless.

It must be realised that most of these patients are constitutionally of poor physique and low resistance. An attempt must be made to persuade them to adapt themselves and their regime to this fact. They need more rest than a normal person, and over-exertion, either physical or mental, only produces aggravation of their symptoms. When, as so frequently happens, the domestic environment is unhappy a frank and sympathetic talk may be beneficial.

As regards the diet, these patients are often undernourished. Often they have cut out successively various articles of diet on the assumption that these disagree with them. The ultimate result may be chronic inanition. There is no need to restrict the diet and often they feel better if they can be persuaded to take more food. In view of the frequency of an irritable

colon and mucous colitis it is wise to avoid foods with much unabsorbable residue. If constipation is a prominent feature it should be treated on the lines described on page 428.

Abdominal belts undoubtedly are often helpful. Although it can be shown by X ray examination that a belt does not appreciably raise the position of the stomach or other viscus it is possible that by raising the intra abdominal pressure it may prevent stagnation of blood in the splanchnic area and thereby improve the circulation. A webbing and elastic belt is more comfortable than one made of leather and metal. Certainly many patients obtain moral if not physical support by wearing a belt.

The best hope of restoring tone to the abdominal muscles is by means of carefully selected exercises involving active rather than passive movements. Such exercises should be performed under the supervision of an expert in remedial exercises. The exercises consist mainly of active movements by the abdominal muscles and the diaphragm which in most of these patients is unduly low with a restricted respiratory excursion. Breathing exercises are carried out lying on the back with the legs drawn up and the thorax partially fixed by the arms folded over the chest, the breathing is thus rendered mainly diaphragmatic in type. Such exercises must be carried out daily at home as well as under supervision.

In the past all sorts of surgical operations ranging from appendicectomy to colectomy, were performed on these unfortunate patients. Happily at the present time operative treatment has practically disappeared, except occasionally for duodenal ileus or Dietl's crises. Not unfrequently one operation led to another and the results were disastrous.

Unfortunately many of the patients labelled as visceroptosis have reached such a condition of chronic invalidism that no cure can be even hoped for, and this is specially the case in those upon whom operations have been performed. In others whose condition is less chronic something may be effected by persistent and sympathetic encouragement.

Drugs are seldom of much value apart from bromide to allay anxiety and a belladonna and hyoscyamus mixture (*vide p 443*) when colospasm is present.

J J CONYBEARE

DISEASES OF THE LIVER, GALL BLADDER, PANCREAS, AND PERITONEUM

DISEASES OF THE LIVER

TESTS FOR HEPATIC EFFICIENCY

UNFORTUNATELY, there is no comprehensive test of the functional capacity of the liver. A careful survey of the symptoms and signs still remains by far the most accurate guide. The lævulose tolerance test often indicates liver inefficiency. Fifty grammes of lævulose are given by mouth, and a rise in the blood sugar level over that of the fasting state of more than 30 mgm per cent during the subsequent two hours is abnormal. The test may, however, give a normal result even when gross liver damage is obviously present the remaining liver cells being equal to the occasion.

A more valuable and simpler test is the galactose test. Galactose is converted into glycogen by the liver with more difficulty than lævulose and is practically not utilisable by any other tissue, and if present in the general circulation is passed in the urine. Under fasting conditions 40 gm of pure galactose are administered by mouth in 250-500 c.c. of water. The urine is voided immediately beforehand and discarded. For the next five successive hours all the urine is collected and the hourly specimens examined for sugar. Those showing a reducing substance are mixed and the quantity of sugar estimated. Normally, 1 gm, or less, of sugar is excreted but any appreciable inefficiency of the liver is shown by there being more than 3 gm of sugar in the urine during the whole five hour period. Cases of toxic and infective hepatic jaundice show the greatest glycosuria while in obstructive jaundice (early or late stage) the test gives a normal result. However, it is not an infallible guide in the differential diagnosis between these two types of jaundice.

Other tests, consisting of the giving of foreign substances such as the dyo phenol tetrachlorophthalein, which are excreted almost exclusively by the liver, are not to be recommended, since they often merely corroborate obvious evidence of disease, and may possibly cause further damage to an already diseased organ

JAUNDICE (*Icterus*)

By jaundice is meant visible staining of the tissues with bile pigment. By special tests its earliest appearance can be demonstrated in the blood plasma, but as deposition in the tissues occurs, it becomes visible in the conjunctivæ mucous membranes of the mouth, the skin of the face and finally of the whole body. It is due either to mechanical defects in the outflow of bile from obstruction of the ducts, to morbid processes in the liver cells themselves, or more rarely it is associated with excessive hæmolysis of red cells. Thus jaundice may be classified as (1) Obstructive hepatic jaundice, (2) toxic or infective hepatic jaundice, (3) hæmolytic jaundice.

Bilirubin, which is formed from hæmoglobin is normally present in the blood plasma in a small but constant amount. The estimation of bilirubin in body fluids by the application of van den Berg's diazo reaction has given great impetus to the investigation of hepatic disease and to the study of the formation of bile pigment. It is recognised that bilirubin can be made quite apart from the liver by the cells of the "reticulo-endothelial system."

The Reticulo-endothelial System—Aschoff introduced this term to describe a system of endothelial cells widely distributed throughout the interstitial and perivascular tissues of the body, they are especially important in the liver (Kupffer cells) spleen, bone marrow, lymph glands, connective tissue and circulating blood.

One characteristic function of these phagocytic cells is the formation of bilirubin from hæmoglobin. Though the Kupffer cells lying along the venous capillaries of the liver are representative of this "system," yet they contribute but a small fraction of the whole number of reticulo-endothelial cells of the body. For this reason the role of the liver as a site for the production of bilirubin is proportionately negligible, and the polygonal cells which make up the main mass of the liver are concerned with the excretion of bilirubin manufactured elsewhere. The bone marrow and spleen are the most important sources. These facts are of great importance in the consideration of the different forms of jaundice.

Bilirubinæmia—While there is no satisfactory method at present for the determination of bile acids in the blood plasma, the content of bile pigment can be estimated accurately by van den Bergh's diazo reaction. The bulk of the bilirubin is formed outside the liver, and the amount found in the blood in health is a small but definite quantity. The process of bile formation consists in the removal of bilirubin from the blood its conversion by the liver cells, and its final excretion into the bile canaliculi. In hepatic disease this selection and excretion of bile pigment is often disturbed so that the bilirubin present in the blood plasma is increased in amount, and may not only be changed quantitatively, but may differ in quality as well.

Blood plasma containing bilirubin, when treated by van den Bergh's diazo reagent, gives a colour reaction which varies with the character of the bilirubin. In one type a red or reddish violet colour appears either at once or in a few moments, and is known as a direct reaction, in another the colour is produced only in the presence of alcohol, after precipitation of the proteins, and is known as the indirect reaction. The direct reaction occurs typically in obstructive jaundice, and the indirect in hæmolytic jaundice. Bile pigment giving the direct reaction will always give the colour by the indirect method, and in the latter a quantitative estimation can be made by comparison with a standard.

The interpretation of the occurrence of these different types of "reactions" is not definitely certain. The character of the bilirubin in the blood in all probability depends on the integrity of the liver cells, so that at one end of the scale, as in pure hæmolytic jaundice, the van den Bergh test shows a completely negative "direct" reaction, and at the other extreme, as in typical obstructive jaundice, the "direct" reaction is always obtained while, in between, a "biphasic" reaction is taken to mean that some form of liver damage is present.

Increased bilirubin in the blood, however, will not always produce visible staining of the tissues, either due to its presence in insufficient amount or owing to a certain quality of the bilirubin. When this condition exists, "latent jaundice" is the term applied, and the van den Bergh test is invaluable for detecting it.

Obstructive Hepatic Jaundice.—The causes of biliary obstruction may be tabulated as follows—

1 Causes within the duct, *e.g.*, gall stones, parasites (these very rarely)

2 Causes in the wall of the duct, *e.g.*, carcinoma of the duct, congenital stenosis, trauma (usually post operative cicatrization)

3 Causes outside the duct e.g. carcinoma of the pancreas chronic pancreatitis enlarged glands in the portal fissure

Depending on the cause obstructive jaundice may be partial complete or intermittent. As soon as the flow is impeded the pressure rises in the bile ducts and absorption of bile into the blood stream results.

The Signs and Symptoms of Obstructive Jaundice—About twenty four hours after the onset of obstruction jaundice becomes visible in the conjunctivæ and mucous membrane of the hard palate. Later the skin of the face neck and body becomes stained. In artificial light slight jaundice is easily missed while on the other hand fat in the lower part of the sclera and in the conjunctivæ may be mistaken for jaundice. At first the colour is light yellow but gradually deepens until in chronic cases the whole skin becomes of a dark green or greenish black hue. Bile pigment and bile salts are present early in the blood plasma and in the urine which becomes noticeably dark in colour. Casts and albumen are often present. With the exclusion of bile from the intestine the stools become greyish white in colour putty like and bulky owing to the large amount of fatty acids and undigested fat. The absence of bile acids from the intestine so diminishes the absorption of fat that the quantity in the stools may rise to nearly 80 per cent instead of the normal 10 per cent. The liver is usually enlarged and the gall bladder may be distended and palpable when the common duct is obstructed by malignant disease. When however obstruction is due to a gall stone the gall bladder cannot become distended and enlarged owing to thickening and fibrosis of its wall. This is known as Courvoisier's law.

If jaundice persists xanthomata (cholesterin topi) may appear anywhere most commonly on the eyelids hands and feet. Telangiectases often develop on the forearms hands face and in the mouth. Operative procedures are dangerous owing to the prolonged bleeding time which results from a lowering of the level of plasma prothrombin. This is due to vitamin K deficiency which develops from poor absorption when bile is excluded from the intestine. This vitamin should be given as a pre operative measure to patients with jaundice. Unlike acholic jaundice the red cells have an increased resistance to hypotonic saline. In the absence of a complicating infection leucocytosis is usually absent. The blood cholesterol is increased and the van den Bergh test gives a direct positive reaction. The pulse is usually said to be slow but this is by no means always true.

Few symptoms are caused by jaundice itself. The pruritus sometimes extremely severe may be pre-icteric and is perhaps due to bile salts. Xanthopsia or yellow vision which is very rare is not dependent on the degree of jaundice but is probably a toxic effect on the retina. Irritability, mental dullness and depression are common. Progressive liver insufficiency leads to serious nervous symptoms such as delirium and convulsions or a typhoid state with dry tongue, hiccough, tachycardia, epistaxis, hæmatemesis and slight fever. This stupor increases to coma and finally death. Such a condition is termed *cholæmia* indicating the failure collectively of the functions of the liver.

Toxic or Infective Jaundice—Jaundice is occasionally seen as a complication in severe infective conditions such as pyæmia, pneumonia, typhoid or typhus. It also occurs as a result of certain poisons such as arseniuretted hydrogen, arsenic, chloroform, TNT and phosphorus. It is also the most prominent feature in catarrhal jaundice and acute yellow atrophy. In all the conditions mentioned above there is no evidence of biliary obstruction and the jaundice is the result of damage to the liver cells resulting from infection or intoxication. There is great variation in the degree of hepatic damage which may range from the acute necrosis of the liver cells seen in acute yellow atrophy to a mild and transient disturbance of function in catarrhal jaundice. There are occasional cases in which this toxic or infective hepatitis becomes subacute and then chronic with much compensatory hypertrophy and varying degrees of irregular fibrosis. In this 'chronic hepatitis' the jaundice may for long periods be latent and the process though slowly progressive is characteristically marked by remissions and exacerbations of the acute or subacute phase.

Phosphorus Poisoning—In this condition the liver is enlarged and friable owing to marked fatty change. Severe gastro-intestinal symptoms are present and death usually occurs rapidly with cholæmic symptoms.

Chloroform Poisoning—This is apt to occur two or three days after chloroform anaesthesia most commonly in children. It is usually fatal with symptoms similar to those of acute yellow atrophy.

Hæmolytic Jaundice—This is the term applied to any jaundice dependent upon the excessive destruction of red blood cells with the liberation of hæmoglobin and its transformation into bilirubin by the cells of the reticulo-endothelial system. This change takes place independently of the liver and the hepatic cells are able to excrete the excess bilirubin brought to them up to a certain point, but beyond this are unable to do

so, and jaundice results. The jaundice occurring in pernicious anæmia is of this type, as is also that in alcoholic jaundice.

CATARRHAL JAUNDICE

Ætiology and Pathology—Catarrhal jaundice is extremely common, especially during adolescence and up to early middle life. Sometimes it occurs in small and localised epidemics.

It has been held that the cause is a gastro duodenitis with swelling of the mucous membrane (i.e., a catarrhal inflammation) which extends up the common duct, and through the œdema of its wall and exudation of thick mucus a plugging of the duct takes place either at the ampulla of Vater (ampulla of bile duct) or higher up, in other words that it is an obstructive jaundice. More recently the view has been taken that whether or no the process be primarily a catarrhal inflammation of the duodenum the jaundice is not obstructive in character but is due to an affection of the hepatic cells, which disturbs their functions in regard to the excretion of bile. The van den Bergh test gives variable results in this condition, sometimes a prompt direct reaction, and at others a biphasic result. The liver is often enlarged during the course of the disease.

Symptoms—Mild gastric disturbance may initiate the attack, with loss of appetite, nausea, a feeling of fullness in the epigastrium and vomiting. These symptoms, with slight fever (100° to 101°) and general lassitude, may precede the jaundice by some days. On the other hand, there may be no gastric symptoms and the patient's attention may be drawn to the disorder by the gradual appearance of jaundice, which is sometimes first noticed by others. Itching of the skin may precede or accompany the jaundice, and can be distressingly severe. The urine shows bld pigment and bile salts early, and the stools become clay coloured. The other symptoms usually abate with the appearance of jaundice. The liver is sometimes enlarged, and slight tenderness under the right costal margin may be present. Some colour may return to the stools, and the jaundice begin to fade in a week, but a duration of three to four weeks, or even longer, is more common. Mental depression and drowsiness may be present, and the pulse is often slow. The return of bile pigment to the stools is the first sign of recovery. Urobilinuria is present when the stools again contain bile pigment disappearing gradually as the liver cells recover.

Diagnosis and Prognosis—Catarrhal jaundice accounts for

the great majority of cases of jaundice occurring before the age of forty. In epidemics the disease may be suspected before the jaundice appears especially as the onset may be unusually severe with chills and vomiting. Liver damage from antisyphilitic treatment with arsenical preparations may at first resemble catarrhal jaundice. In old people the persistence of clay coloured stools beyond six weeks especially without abdominal pain should arouse suspicion of graver conditions such as carcinoma of the head of the pancreas. Obstruction by gall-stones in the common bile duct may also be a possibility even without biliary colic. Attacks of fever and intermittent biliary obstruction as shown by the occasional presence of bile in the stools point to stone in the common duct. The jaundice in obstruction due to malignant disease may deepen to a green tint but in catarrhal jaundice it remains bright yellow. Mild cases of spirochaetosis ictero-haemorrhagica may be clinically indistinguishable from catarrhal jaundice.

Treatment—The patient should be put to bed. If there be nausea and vomiting it is best to give nothing by mouth except water or fluids such as orange juice lemonade or soda water. It is essential that the diet should be high in carbohydrate and as low in fat as possible. Biliary antiseptics such as salicylates and hexamine are of questionable value. The bowels should be opened daily by a morning saline. The injection of 33 per cent magnesium sulphate through a duodenal tube has been said to shorten the course of the illness but it is doubtful whether the trouble and discomfort involved in such a procedure are justifiable.

ACUTE YELLOW ATROPHY

Ætiology—In most cases of acute yellow atrophy there is no obvious cause for the disease. Poisons such as trinitrotoluene chloroform or arsenic may sometimes produce degeneration and necrosis of the liver cells but perhaps the most frequent associated factor is pregnancy. It is in consequence of the latter fact that the disease is more common in females than in males. Other very rare causes are acute infections such as typhoid and influenza excessive alcoholism and ingestion of poisonous mushrooms (*Amanita phalloides*).

Pathology—There is an acute necrosis of the liver cells with autolysis. The liver is shrunken and flabby with a wrinkled capsule. In colour it is yellowish green and may appear mottled from subcapsular hemorrhages. On section

the liver pulp is soft, and shows yellow and red areas, the latter consist of completely necrosed cells, while in the yellow areas the structure of the liver is to some extent preserved. The cells are seen to be in all stages of necrosis, and in parts the section may be unrecognisable as liver. If the process has been subacute, nodules of hyperplasia are seen, beginning in the cells at the periphery of the lobules. A little bile may be found in the gall bladder, but the bile ducts mostly contain clear mucus only. The spleen is somewhat enlarged and soft and the renal epithelium shows degenerative changes.

Symptoms—The disease usually consists of two fairly well defined stages, the first of which lasts five to six days but may be as long as three weeks, the onset is insidious with malaise, slight fever, jaundice, and vomiting. The second or "typhoid" stage is marked by severe nervous symptoms closely resembling meningitis. Headache, irritability, delirium, muscular twitching, and convulsions occur, sometimes with temporary paralysis and squint. The jaundice increases, vomiting becomes violent and there may be blood in the vomit. The pulse is feeble and rapid, the tongue dry and coated, the pupils dilated and the temperature is often subnormal, but may rise quickly just before death. Subcutaneous and submucous hæmorrhages are common. Though at the onset the liver may be enlarged and tender there is soon a rapid diminution in size, and the hepatic dullness may disappear as the organ softens, shrinks and falls back, allowing the intestine to overlap it. Occasionally, severe pain occurs when patches of further necrosis take place suddenly. The spleen sometimes becomes palpable. From the early cessation of bile formation the stools become clay coloured. Drowsiness increases to stupor and coma, until death occurs. This may take place at any time from two to seven days after grave symptoms develop. The urine is diminished in amount and contains bile pigment, albumen and casts. Lencin and tyrosin crystals may occasionally also be found. The van den Bergh test gives an immediate direct reaction.

Diagnosis—Jaundice, severe gastro intestinal and nervous symptoms, and diminution of the size of the liver make the diagnosis clear. The predominance of the liver atrophy distinguishes it from other forms of severe toxic jaundice, such as phosphorus poisoning. Severe spirochætal jaundice may be confused with acute yellow atrophy but in the former disease the liver is usually normal in size.

Prognosis and Treatment—In acute yellow atrophy the outlook is hopeless. Subacute types of the disease may live for a considerable period, and perhaps recover.

Once severe symptoms have become manifest no treatment is of any real avail. Intravenous glucose and alkalies by mouth and rectum should be given. Morphia and venesection may give temporary relief.

AFFECTIONS OF THE BLOOD VESSELS OF THE LIVER

By the layman, gastro intestinal upsets of all types are apt to be ascribed to "chills on the liver". In actual fact there is little or no evidence that in such conditions the liver plays any appreciable part. The symptoms attributed to a disordered liver, such as anorexia, nausea, constipation, headache or irritability are probably more frequently due to a chronic gastritis.

In congestive cardiac failure, however, chronic venous congestion of the liver produces characteristic symptoms and signs which need further description.

Chronic Venous Congestion—This results from the occurrence of congestive cardiac failure (*vide p. 540*). The liver is much enlarged, and on section shows a characteristic "nutmeg" appearance, due to the dark congested centres of the lobules, surrounded by paler areas of fatty degeneration.

Symptoms—Rapid onset of hepatic congestion, causing increase in the size of the liver, produces epigastric pain and tenderness from sudden stretching of the capsule. When there is trienspid incompetence the liver may be felt to pulsate, due to regurgitation into the hepatic veins. The impulse from the direct pulsation of the heart transmitted through the diaphragm must be distinguished from true expansile pulsation. This is best felt with one hand over the liver in the epigastrium and the other at the costal margin in the mid axillary line. There is a feeling of fullness in the epigastrium, loss of appetite, often nausea and vomiting. There is an increase in the bile pigment in the blood plasma, as shown by van den Bergh's test and the amount varies directly with the degree of heart failure. Sometimes the patient has obvious icterus, but the jaundice may be "latent". Ascites is common, especially when there is cedema of the extremities.

Treatment is that detailed for cardiac failure (*vide p. 543*).

Thrombosis of the Portal Vein—This rare condition is occasionally met with in cirrhosis of the liver. Malignant disease in the neighbourhood or in the liver may also cause thrombosis by infiltration of the vein wall and its lumen. Though not often diagnosed, it may be suspected where there is a sudden onset of severe portal obstruction with rapid

increase in ascites and with hæmatemesis melæna and enlargement of the spleen followed by severe symptoms of hepatic insufficiency

SUPPURATIVE DISEASES OF THE LIVER

Suppurative Pylephlebitis—This condition often termed portal pyæmia has become relatively uncommon since the importance of early operation in cases of appendicitis has been generally recognised. It may follow suppuration with septic phlebitis in any part of the area drained by the portal vein most commonly the appendix and the rectum. The septic process spreads up the portal vein into the liver and at autopsy there are multiple abscesses in the liver and sometimes pus in the portal vein.

The symptoms are those of a pyæmia with rigors often at first few signs point to involvement of the liver but in the later stages the patient generally becomes slightly jaundiced and the liver is found to be enlarged and tender. The leucocyte count is high and effusions clear or purulent may occur in the right pleural cavity.

The disease is invariably fatal and nothing beyond palliative treatment is available.

Abscesses of the Liver—Apart from portal pyæmia amœbic abscess (*vide p 189*) and actinomycosis of the liver (*vide p 87*) hepatic abscess may result from suppuration of a hydatid cyst (*vide p 211*). Suppurative cholangitis usually secondary to disease of the gall bladder may lead to multiple hepatic abscesses and suppuration in the liver is a rare complication of trauma such as bullet wounds in this region.

CIRRHOSIS OF THE LIVER

(*Portal Alcoholic Lannec's Multilobular Cirrhosis*)

Cirrhosis is chiefly a disease of males in adult life but it is also occasionally seen in women and children. Chronic alcoholism is by far the most important though by no means its only cause. Occasionally cirrhosis occurs in total abstainers. Possibly it is not so much alcohol itself as the chronic gastritis which results from abuse of alcohol which leads to cirrhosis. Other substances such as spices curries and condiments may predispose to cirrhosis.

The disease at the present time is certainly less common

both in England and in America than was the case twenty years ago. This decrease is the result of the greatly increased cost of alcohol and a resulting diminution in consumption.

Pathology—The weight of the liver varies considerably (900 to 6 000 grm.) depending partly upon the relation between the compensatory hyperplasia, the degeneration of cells, the increase in fibrous tissue and the amount of fat present. The term atrophic cirrhosis is applied when the liver is smaller than normal, but as far as the number of actively functioning liver cells is concerned, there is probably no great difference between the very large and the very small. Patients with cirrhosis who die of liver insufficiency usually have smaller livers than those who die from other causes. The surface is irregular due to contraction of fibrous tissue and to proliferation or regenerating cells (hobnails). In the larger livers the surface may be merely coarsely granular, in the smaller the whole organ may be puckered and deformed. The capsule may be thickened and opaque from perihepatitis. On section the hobnails have a yellow or tawny appearance from which the name cirrhosis is derived. The liver substance is divided in a most irregular manner by greyish white fibrous tissue which spreading out from the portal areas encloses a varying number of lobules (hence the term multilobular). The liver cells are compressed and degenerated. As a result of the portal obstruction produced by the fibrous tissue collateral anastomoses for a compensatory circulation are extensive and are carried out by the following sets of vessels—

- 1 The gastric veins draining into the portal system anastomose with the œsophageal veins of the systemic circulation around the lower end of the œsophagus. With portal obstruction œsophageal varices may be formed and if ruptured produce severe hæmatemesis.

- 2 The hæmorrhoidal (rectal) plexus forms an anastomosis between the superior hæmorrhoidal veins which drain through the inferior mesenteric and splenic veins into the portal system and the middle and inferior hæmorrhoidal veins which drain into the inferior vena cava. Varices of the plexus produce hæmorrhoids, but the latter condition occurs so frequently in otherwise normal adults that their presence cannot be regarded as suggestive of cirrhosis.

- 3 The veins of Retzius connect the intestinal veins with the inferior vena cava and its retroperitoneal tributaries.

- 4 The para umbilical vein running with the round ligament of the liver may form an anastomosis between the left branch of the portal vein and the veins of the abdominal wall. Very

rarely this produces a bunch of prominent veins at the umbilicus known as a *Caput Medusæ*

Symptoms—As long as the collateral circulation and compensatory hyperplasia are sufficient there may be no symptoms. Thus there are latent cases in which discovery of the condition is due to accident or to the occurrence of some other disease. It is impossible to determine with any accuracy the length of time cirrhosis has been present.

The onset in cirrhosis is variable. Occasionally patients are encountered in whom a sudden, and often severe hæmatemesis is the first sign. Less commonly there is a somewhat rapid onset of ascites due to portal obstruction. In most cases, however, there is a well marked history of chronic gastritis which extends back for many years and precedes any symptoms of cirrhosis. It must be clearly realised that the morning anorexia and vomiting which are a feature of nearly all cases of cirrhosis are due not to the liver condition but to a gastritis, usually induced by chronic alcoholism.

When the disease is fully developed the patient presents a characteristic picture. The nutrition is poor, with loss of subcutaneous fat, so that the face and neck are thin and drawn. The eyes are sunken with an icteric tint. The complexion is of a dirty sallow hue. There are minute dilated vessels over the face and body (spider angiomas), the skin is dry, inelastic, and may show pigmentation. The tongue is flabby and furred, the gums are spongy and bleed readily. The breath is offensive, and the lips dry and cracked. A ring of minute dilated venules in the lower thoracic region is often seen along the attachment of the diaphragm but is however not uncommon apart from cirrhosis. The abdomen is enlarged by the ascites, the amount of ascitic fluid may be too great to allow satisfactory palpation, but with a lesser quantity the liver can often be felt by dipping down sharply on it. It is often considerably enlarged diminishing in size as the disease progresses though it may be small from the beginning. On withdrawal of fluid, the sharp edge and the hard surface can be felt, and its granular or hobnail character can sometimes be made out. With marked atrophy, the area of liver dullness is decreased. The spleen is easily felt in many cases.

Slight jaundice is present in a third of the cases but the van den Bergh test will show an increase in the plasma bilirubin in a rather larger percentage. The reaction is direct either delayed or biphasic. Slight irregular fever of 99° to 102° may be present.

In the earlier stages of cirrhosis the main symptoms are those of chronic gastritis. As portal obstruction develops, ascites becomes a prominent feature, and in addition there may be oedema of the feet. Hæmatemesis from rupture of oesophageal varices may occur, and is occasionally fatal. Later still, symptoms of hepatic insufficiency develop, and the patient may die of exhaustion and toxæmia.

Complications—A very sudden onset of ascites usually indicates portal thrombosis, but it is a rare occurrence. Sometimes a chronic peritonitis aggravates the ascites due to portal obstruction. The fluid will then have a specific gravity of over 1.015 and polymorphonuclear cells are present. Patients with portal cirrhosis are very susceptible to intercurrent infection, and may develop pulmonary tuberculosis and sometimes tuberculous peritonitis. Primary carcinoma of the liver is a rare complication.

Differential Diagnosis—This is discussed on page 463.

Prognosis—The prognosis depends mainly on the extent of the liver damage present when the patient is first seen. When this is considerable, whatever treatment he adopted the outlook is poor. If the condition be discovered before the advent of ascites, and the patient live a strictly ordered life directed towards the avoidance of such substances as are prone to cause liver damage, the disease may be arrested. Once ascites has occurred, little can be done, if, however, it be due to a complicating peritonitis, the fluid may disappear. Hæmatemesis, even though recurrent, is seldom fatal.

Once toxæmic symptoms appear, death will usually take place in a few months.

Treatment—The majority of patients with cirrhosis are alcoholics, and in dealing with them it is important to insist on complete and permanent abstention from alcohol. Other possible causes of chronic gastritis, such as spiced foods and condiments should also be forbidden, and the patient, especially if elderly or middle aged, should be put on a low diet with a relative increase in carbohydrates. The frequent use of salines to keep the bowels regular is important. Hæmatemesis should be treated with morphia, and, if much blood be lost, a blood transfusion may be necessary. In the ascitic stage tapping will relieve the abdominal discomfort (*vide p. 489*).

HEMOCHROMATOSIS (*Diabète Bronze*)

This is a rare form of cirrhosis of the liver associated with some disturbance of iron metabolism, occurring chiefly in men.

of middle age. It is characterised by a remarkable darkening of the skin, which has a bluish grey sheen due to the deposition of an iron containing pigment, hæmosiderin. Weakness is the chief complaint, and there may be attacks of intestinal colic and great prostration. There is a hæmolytic anæmia of moderate degree, enlargement of the liver, and a palpable spleen. Hæmosiderin may be found in the urine. The deposition of pigment in the organs causes fibrosis. The pancreas is commonly affected, and the chronic pancreatitis often produces diabetes mellitus, which is difficult to control. This latter condition gives the disease its alternative name of bronzed diabetes. There may be partial recovery, but usually death results from hepatic insufficiency and acidosis.

HYPERTROPHIC BILIARY CIRRHOSIS

The term hypertrophic biliary cirrhosis probably includes a number of different pathological conditions, all of which are rare. Hanot in 1875 described a number of cases with enlargement of the liver and spleen with jaundice abdominal pain, vomiting and fever, but it is doubtful whether the so called Hanot's cirrhosis is a clinical entity. It has already been mentioned (*vide* p. 454) that toxic or infective hepatitis may become chronic and lead to fibrosis and hypertrophy of the liver. Chronic infection or obstruction in the bile passages, such as may result from stones or infection in the gall bladder, occasionally produces a secondary biliary cirrhosis.

The liver is usually very large. Its surface may be relatively smooth or areas of regeneration may render it irregular. The spleen is also often enlarged and fibrotic.

Clinically there is a great variation in the symptoms of individual cases. Jaundice may be more or less persistent or occur only in attacks, and gastro intestinal symptoms, such as colicky pain, nausea and vomiting are not constantly present.

When hypertrophic cirrhosis appears to have arisen secondarily to chronic infection of the gall bladder, cholecystectomy may prevent further damage to the liver. In all cases plenty of glucose should be given and the fats in the diet kept low. Alcohol should be forbidden. Sometimes injections of insulin (up to 10 units twice daily) followed by ingestion of glucose appear to help to improve liver function.

SYPHILIS OF THE LIVER

In congenital syphilitic infants the liver and spleen are often enlarged, and contain great numbers of spirochetes. The liver cells are surrounded and compressed by a fine pericellular cirrhosis, and the infant usually dies at or shortly after birth. Congenital syphilis of the liver is also sometimes seen during adolescence. The condition then resembles the irregular gummatous liver of acquired syphilis.

In the secondary stage of acquired syphilis there may be an acute hepatitis, which results in jaundice, often associated with a painless but sometimes persistent hepatic enlargement. This must be distinguished from the jaundice which sometimes follows the administration of arsenical compounds.

Tertiary Syphilis—(*Syphilitic Cirrhosis of the Liver*)—Gummata are not very uncommon in the liver, and are much more frequent in men than in women, appearing ten to twenty years after infection.

Pathology—Remarkable deformities result from the combination of scarring due to healed gummata and the nodules produced by more recent lesions. Multiple granulomatous areas with necrosis of the central portion are surrounded by a fibrous capsule, contraction of which, with absorption of the caseous centres, produces extensive puckering of the liver surface. Adhesions to neighbouring structures may develop. Amyloid degeneration may occur as a complication, and may involve also the spleen, kidneys, and intestine.

Symptoms and Signs—There are often none, the gummata and cicatrices being discovered post mortem. General symptoms of wasting, weakness, slight fever and secondary anemia without leucocytosis occasionally precede abdominal discomfort or pain. With much fibrosis throughout the organ, or adhesions or enlarged glands in the portal fissure there may be portal obstruction resulting in ascites, with gummata near the surface a perihepatitis or a syphilitic peritonitis may give rise to ascites. Chronic jaundice is rare but may be associated with splenomegaly. Gummata of the liver often produce a most irregular enlargement of the organ, which may be easily palpable and may be mistaken for a growth.

Differential Diagnosis is dealt with elsewhere (vide p. 465).

Treatment—Large doses of potassium iodide (100 to 200 gr. daily) should be given, together with mercury by inunction (5 to 10 grm. of Ung. Hydrarg. B.P. daily). Such treatment produces a rapid improvement. Arsenical preparations are to be avoided in these patients.

MALIGNANT DISEASE OF THE LIVER

Pathology.—Primary new growths in the liver, whether carcinoma or sarcoma, are very rare. The most frequent occurrence of primary carcinoma is in association with cirrhosis. In this form there are multiple small growths throughout the liver substance. The disease runs a rapid course with signs of liver insufficiency.

The liver is more frequently involved by secondary deposits of carcinoma than any other organ. These produce some of the largest livers found at post mortem, weighing up to 30 lbs or even more. The primary growth is most commonly of the stomach, and next in order of frequency are the colon, œsophagus, pancreas, gall bladder, uterus, and breast.

Symptoms and Signs.—Gradual enlargement with irregularity of surface is the chief characteristic of growth in the liver. Nodular masses with central depressions or umbilications can be felt or even seen through the abdominal wall. The organ may reach below the umbilicus. Sometimes the left lobe is more affected than the right, producing a large mass in the epigastric region. The deposits near the surface are apt to cause considerable pain and tenderness from peritonitis, and friction rubs may be heard.

Jaundice is present in half the cases, but is seldom intense. Ascites occurs with about the same frequency as jaundice, but both in combination are less common. The ascites may be due to the pressure of nodules on the portal vein, but more often to extension of the growth to the peritoneum. The veins in the abdominal wall are enlarged, and rarely there may be nodules of carcinomatous tissue about the navel. The patient is markedly cachectic, the face is cadaverous, and there is severe hypochromic anemia, weakness and loss of flesh are progressive. An irregular fever is frequently present even without suppurative complications. Oedema of the feet is common. Widespread involvement of the liver ultimately produces death in coma from liver insufficiency.

Differential Diagnosis.—See below.

Treatment.—Morphia should be given freely when necessary, and the bowels can be kept regulated by salines and mild laxatives. When there is any possibility of doubt as to the diagnosis, an exploration is justifiable.

DIFFERENTIAL DIAGNOSIS OF HEPATIC ENLARGEMENT

Hepatic enlargement is often the most prominent feature in pathological conditions of the liver, but before considering

the differential diagnosis it is important to stress the fact that not every palpable liver is enlarged. Weakness of the abdominal muscles and a general visceroptosis may result in the liver being considerably lower in the abdomen than is normally the case. In addition to such a ptosis of the organ, a thin abdominal wall facilitates palpation, and thus gives a false impression of the size of the liver. In such cases careful percussion of the upper border of the liver may show that the liver dullness does not extend up to its normal position in the thorax: i.e. the fifth intercostal space in the right nipple line. Too much stress however, must not be laid on variations in the extent of the liver dullness, which is much influenced by such factors as emphysema or intestinal distension.

The causes of enlargement of the liver are tabulated below

- 1 Chronic venous congestion (nutmeg liver)
- 2 Abscesses (single or multiple)
- 3 The cirrhoses (a) portal, (b) gummatous, (c) splenic anæmia, (d) bronzed diabetes, (e) biliary
- 4 Growths, primary or secondary
- 5 Cysts hydatids
- 6 Lardaceous disease
- 7 Hodgkin's disease and the leukaemias

In the majority of cases a careful history and general physical examination are often sufficient to decide the diagnosis.

Acute infections of the liver resulting in abscess formation whether single or multiple are usually relatively easy to diagnose. Pyrexia of a hectic type, local tenderness over the liver, leucocytosis, and occasionally nuchal rigidity, all suggest hepatic suppuration which may be secondary to amœbic infections of the colon or to an inflammatory focus in the portal area.

The main diagnostic problems arise in the differentiation of hepatic enlargements due to growths, cirrhosis, and hydatid disease. Age and sex afford little help, and both with growth and cirrhosis emaciation and cachexia are severe. Chronic enlargement of the liver with little or no impairment of the general health is almost diagnostic of hydatid cyst. The diagnosis may be confirmed by an eosinophilia, a positive complement fixation test or more rarely the finding of a hydatid thrill (*vide p. 211*).

In every case of hepatic enlargement, especially after the age of forty, careful search must be made for a primary growth which sometimes may give little evidence of its presence. Careful examination of the prostate, testicles, and breasts is important. Primary carcinoma of the liver is so rare that consideration of this possibility may for practical purposes be

neglected Secondary melanotic sarcoma may give rise to great hepatic enlargement months or even years after the primary growth in the eye or skin has been removed. Melanin is found in the urine. Of the cirrhotoses, by far the most common is portal cirrhosis. A history of chronic alcoholism and evidence of chronic gastritis in the form of morning anorexia and vomiting will suggest this diagnosis. Newly formed spider angiomas are also often seen in cirrhosis.

Pyrexia is common in the later stages of both growth and cirrhosis. Its presence therefore in a patient with enlargement of the liver does not exclude the possibility of these conditions.

If in addition to hepatic enlargement the spleen is also enlarged the patient is probably suffering from cirrhosis rather than growth. If the splenic enlargement is considerable and particularly if it is associated with secondary anaemia or hæmitomesis Banti's disease is probable. Other types of cirrhosis such as Hanot's and bronzed diabetes are excessively rare. In the latter, pigmentation and glycosuria point to the correct diagnosis. In Hanot's cirrhosis the patient is much younger than is usually the case in portal cirrhosis, and jaundice is a more marked feature. Ascites is common both with growth and cirrhosis and has little diagnostic import.

Very valuable information is obtained from physical examination of the liver. With growth the organ is often very much enlarged and hard, but the most characteristic feature is the irregularity of the surface which can be readily noted on palpation. The irregularities correspond to projecting nodules of new growth, which often attain a size of several inches in diameter. The umbilication of the deposits which is apparent at autopsy can sometimes be felt during life. In portal cirrhosis the liver surface feels hard, but it has not the gross bosses and irregularities palpable in growths. If the abdominal wall be very thin it may be possible to feel the roughening of the surface due to "hobnails". Extreme irregularity of surface is encountered in gummatous conditions of the liver, this is likely to be confused with secondary deposits but a positive Wassermann test and a diminution in the size of the liver under treatment with iodides help to justify the diagnosis.

Abnormalities in the shape of the liver may lead to errors in diagnosis. A tongue like projection of the right lobe of the liver often associated with chronic inflammatory conditions in the gall bladder, may protrude downwards and is known as Riedel's lobe.

A chronic solitary abscess may produce great enlargement of the liver, and is liable to be misdiagnosed as growth.

Pyrexia, leucocytosis, and local tenderness may be completely absent. In doubtful cases laparotomy is advisable.

Amyloid disease of the liver may produce some of the largest livers encountered at autopsy. The organ is smooth, firm, and painless. The disease is usually generalised and also affects the spleen, kidneys, and intestines. It occurs in suppuration of long standing, such as results from chronic osteomyelitis, empyema, and chronic tuberculosis. Anæmia, albuminuria, and diarrhoea are common.

DISEASES OF THE GALL-BLADDER AND BILE DUCTS

CHOLECYSTITIS

Acute Catarrhal Cholecystitis—Acute cholecystitis occasionally occurs as a complication of enteric fever. Like acute appendicitis, however, it usually arises apparently spontaneously and without any ascertainable cause. Possibly focal infection, such as suppuration around the teeth or in the tonsils, may play a part in its production. Ascending infection from the duodenum is probably not an important factor. Predisposing causes are (1) a previous inflammation, (2) the presence of gallstones, (3) conditions favouring stasis of bile in the gall bladder.

On bacteriological examination of the bile the majority of cases show a pure culture of *Bacillus coli*, but it is probable that this represents a secondary infection and that the original organism, usually a non-hæmolytic streptococcus, has died out. In cholecystitis associated with typhoid fever the typhoid organism may persist in the bile for years.

Pathology—In early lesions a mild catarrhal inflammation is present, with congestion and oedema of the mucosa. Later the mucous membrane is reddened, and becomes thickened and covered with mucus and fibrin. With a more intense inflammation, usually in the presence of gallstones, suppuration or necrosis of the wall may result in perforation.

Symptoms—These vary with the virulence of the infection. Severe continuous pain with colicky exacerbations in the right upper abdomen is the commonest symptom. There are also vomiting and fever, while clinical examination reveals tenderness under the right costal margin, rigidity of the right rectus and lack of movement of the right dome of the diaphragm. In the absence of rigidity an enlarged gall bladder may sometimes be palpable. A moderate leucocytosis is present.

Acute Suppurative Cholecystitis—If the condition progress to suppuration symptoms and signs both local and general become aggravated. Rigidity is increased, pulse and temperature rise, and the patient is obviously toxæmic. A leucocyte count will show an increase over that found in the catarrhal stage. Perforation results in a localised abscess rather than generalised peritonitis.

Diagnosis—Differentiation from acute appendicitis may be difficult especially when the appendix lies high in the abdomen. Acute pyelitis on the right side should be excluded by examination of the urine. Gallstone colic gives more agonising pain and no signs of local peritonitis.

Treatment—Catarrhal cholecystitis may subside spontaneously. If there be any history suggestive of previous attacks or of gall stones an exploration should be advised and cholecystectomy performed.

Chronic Cholecystitis—Chronic cholecystitis often follows an acute attack and should gall stones be formed there is a tendency for the acute phase to recur. It is often associated with some degree of cholangitis and sometimes with chronic appendicitis. The gall bladder may be adherent to adjacent structures. The wall is thickened and the whole organ becomes shrunken. The mucous membrane and muscle layer may be largely replaced by fibrous tissue, and there are focal areas of lymphocytic infiltration. The remnants of the mucous membrane are thrown up in relief and become distorted into adenoma like masses. In addition gall stones are often present.

Symptoms and Signs—The digestive symptoms are characteristically variable and irregular, often with long intervals of freedom. In some cases they resemble those of gastric or duodenal ulcer especially the latter. The most constant symptoms are feelings of fullness, flatulence and less commonly pain coming on immediately or several hours after food or occurring at night. Nausea especially following a fatty meal is frequent. There may be pain simulating biliary colic and indeed it is often impossible to say whether stones are present. The pain is usually in the neighbourhood of the right costal margin but sometimes it may be located in the midline of the epigastrium. It is often propagated to the side and back and into the right scapular or shoulder region.

Tenderness over the gall bladder under the eighth and ninth costal cartilages is the most constant sign. It is best elicited by getting the patient to take a deep breath while the region of the gall bladder is being palpated. When the inflamed organ

comes into contact with the hand of the examiner there is a spasm of pain and a catch in the breath (Murphy's sign). This, however, is not necessarily always found, though usually present during or shortly after an exacerbation.

Test-meal examinations show no characteristic features. Occasionally small amounts of occult blood are found in the faeces, especially when stones are present.

Treatment.—If there be no serious adhesions, some improvement may be expected with medical treatment. Foci of infection should be eradicated. A diet poor in cholesterol is advisable as an aid in the prevention of calculi. Such foods as eggs, kidneys, liver, pancreas, brains, animal fats, cream, butter, and fried fish ought not to be taken. It is best to have the vegetables put through a sieve. It has been shown that hexamine is excreted in the bile, and the drug may be given as a biliary antiseptic. To be effective large doses must be taken, and Hurst recommends up to 100 gr. daily. Sufficient alkali in the form of potassium citrate and sodium bicarbonate must be given to keep the urine alkaline, or cystitis may result. Sulicylates may also be given as a biliary antiseptic. It is advisable to take 1 or 2 dr. of saturated magnesium sulphate solution every morning, as this produces emptying of the gall-bladder.

If symptoms persist in spite of medical treatment, stones or adhesions are usually present, and cholecystectomy should be performed. It must be realised that even at laparotomy diagnosis of a pathological gall-bladder is not always easy. If the abdomen has been opened for suspected disease of the gall-bladder, the organ should always be excised, whether macroscopically it appears grossly abnormal or not, unless there be some other obvious condition in the abdomen to explain the symptoms.

GALL-STONES (*Cholelithiasis*)

Ætiology.—Gall-stones may occur at any age, but the main incidence of symptoms is upon women of forty and over, who have borne children. The production of gall-stones depends on the presence of several factors.

1. *Infection.*—Inflammation prevents satisfactory emptying of the gall-bladder, with resulting stasis of bile. In addition, the inflammatory exudate contains mucus, bacteria, degenerated epithelium, and leucocytes, which may act as nuclei for the formation of stones. A lessened bile-salt concentration may also aid in this precipitation. Various organisms are responsible

for the initial infection. Typhoid bacilli have occasionally been cultured from the centre of calculi. The streptococcus is probably an important agent. *Bacillus coli* is more often discovered than any other organism, but is probably a secondary invader.

2 Blood Cholesterol—This is derived from endogenous and exogenous sources. The former include the cortex of the adrenals and the corpora lutea during menstruation. During pregnancy there is an increase in the blood cholesterol, and often gall stone symptoms first make their appearance at this time. The exogenous sources are articles of diet such as sweetbreads, liver, kidney, brains cream butter and eggs.

3 Biliary Stasis—Sedentary occupations and obesity hinder complete emptying of the gall bladder and so add to the risk of infection.

Composition of Gall-Stones—The commonest form are those composed of cholesterol and bilirubin calcium. They are usually multiple dark brownish green in colour, stratified, and often faceted unless enormous numbers be present, when they are usually round. Single stones are either pure cholesterol and not caused primarily by infections or are composed mainly of cholesterol with a small amount of bilirubin calcium as an outside layer. Pure pigment stones occur in acholuric jaundice.

Symptoms and Signs—Although it is true that gall-stones are found at autopsy in patients who have died of other conditions it is doubtful whether the presence of stones is often unaccompanied by symptoms. These fall into two main types (1) gall bladder dyspepsia, (2) biliary colic. The former has already been described in connection with chronic cholecystitis (*vide p. 469*).

Biliary Colic—Spasm of the smooth muscle in the wall of the cystic and common ducts due to the presence or passage of calculi, causes intense pain. These attacks of colic may occur at any time, sometimes following exercise or jolting. The pain may be moderately severe or extraordinarily violent, and the attacks last from a few moments to many hours. The sudden onset and an equally sudden cessation are most characteristic. The pain starts in the right hypochondrium, but may be felt first in the epigastrium. It radiates towards the axilla and up into the right shoulder. The passage of a calculus through the cystic duct is usually slow, and causes one of the most extreme types of suffering. Sometimes, however, attacks of biliary colic may be much less severe. There may be shivering without fever, or the temperature may reach 103°. There is great restlessness, and the pain may be

so agonising as to cause the patient to roll about. Vomiting, profuse sweating and shock may be severe.

Following an acute attack considerable soreness is felt in the gall bladder region which may last for some days, and there may be jaundice of varying duration and severity.

Effect of Calculus in the Cystic Duct—Biliary colic due to a stone in the cystic duct does not produce jaundice. Should the walls of the gall bladder not be fibrosed the organ may become greatly distended by mucus. After a time the bile pigment is absorbed, clear mucoid material remaining (mucocoele). The enlarged gall bladder forms a rounded tumour palpable below the liver, sometimes extending below the umbilicus. It may be mistaken for a large kidney or an ovarian cyst. Under these conditions an acute cholecystitis may complicate the picture and empyema of the gall bladder is a common sequel. Ulceration of the wall and perforation may rarely occur.

Effect of Calculus in the Common Duct—Single or multiple stones may be present. The usual site is the lower end, in the ampulla of Vater (ampulla of the bile duct), where the diameter is least, but there may be stones throughout the common and hepatic ducts. The obstruction to the duct may be (a) complete or (b) partial or intermittent.

(a) *Complete Obstruction*—The ducts may become much dilated. The gall bladder is usually not enlarged owing to a coexistent fibrosis due to cholecystitis. Jaundice is always present and is deep in hue. There is as a rule no fever.

(b) *Partial or Intermittent Obstruction*—This is the usual effect of stones in the common duct. A calculus in the ampulla of Vater has a ball valve action. The common duct may be so much dilated as to be almost cystic and the dilatation continues into the hepatic and intra hepatic ducts. The liver enlarges but may decrease in size later, due to a secondary biliary cirrhosis (vide p. 463).

There is no enlargement of the gall bladder, which is thickened by chronic inflammation. Characteristic symptoms are attacks of chills and fever, nausea and vomiting, sometimes severe colic, marked jaundice and lessened bile in the stools. These paroxysms (intermittent hepatic fever of Charcot) are due to infection of the ducts and to some extent of the liver when the obstruction becomes temporarily more complete. The chills are severe and the fever may reach 105°. The van den Bergh test shows an immediate direct reaction and there is a leucocytosis. These attacks may recur over a number of years. If suppuration take place in the ducts the fever

becomes remittent, the jaundice is not so marked but the liver increases in size and may be tender from suppuration. *Suppurative cholangitis is a fatal complication*

Complications of Gall-Stones—Acute, subacute, and chronic cholecystitis are accompaniments of gall stones and can hardly be designated as true complications. A gall stone in the ampulla of Vater may cause bile to flow up the duct of Wirsung (the pancreatic duct) and set up acute hæmorrhagic pancreatitis. As a result of pericholecystitis, the gall bladder may become adherent to neighbouring structures and inflammatory change spread to them with the possibility of the formation of abscesses or fistulæ. In the abdominal cavity fistulæ may form between the gall bladder and the duodenum or colon. If a stone pass through a fistula into the lumen of the intestine it may be passed in the fæces or, if large it may produce acute obstruction (gall stone ileus) this impaction most commonly occurs in the lower part of the ileum.

Diagnosis of Biliary Colic—The diagnosis is made by the typical position and character of the pain, and the presence of jaundice or the history of its appearance in some former attack. Renal colic is usually felt first in the loin, or lower down in the abdomen, radiating to the bladder and genitalia, and the urine may contain blood cells. The dyspepsia associated with gall stones sometimes simulates a duodenal ulcer very closely. Adhesions of the gall bladder to the duodenum may produce X ray appearances very suggestive of duodenal ulcer. The failure of duodenal symptoms to react to strict medical treatment is always suspicious and not infrequently in such cases the gall bladder ultimately proves to be diseased. The gastric crises of tabes may imitate gall stone colic very closely, and the pupils and reflexes should be examined. The discovery of stones in the fæces makes the diagnosis certain, but masses of soaps from the therapeutic use of olive oil are often mistaken for gall stones by patients.

Treatment—When the presence of gall stones is certain whether they be in the gall bladder or bile ducts operation is advisable, provided there be no contraindications in the general condition of the patient. With palliative treatment further trouble is very frequent and operation may have to be undertaken at a later date, possibly under less favourable circumstances. The operation of choice is cholecystectomy.

The reduction of obesity, the taking of moderate exercise, the strengthening of the abdominal muscles in visceroprotic patients, more frequent and smaller meals with food of low cholesterol content, and the administration of cholagogues

such as magnesium sulphate, saheylates, and bile salts are all advisable when operation cannot be performed. Hexamine and saheylates may be given as biliary antiseptics. For biliary colic, morphine and atropine are required.

AIDS TO THE DIAGNOSIS OF GALL BLADDER DISEASE

Radiograms of the gall bladder region may show the shadows of stones, provided they are not pure cholesterol. A barium meal may show distortion and filling defects of the pyloric end of the stomach or of the duodenum if there are adhesions from the gall bladder.

Cholecystography—This method of visualising the contents of the gall bladder was introduced by E. W. Graham. It depends on the fact that bile is concentrated in the gall bladder by the absorption of water through the mucous membrane. Certain dye substances, such as tetra iodophenolphthalein or the isomeric compound phenol tetra iodophthalein are excreted by the liver, and when sufficiently concentrated in the gall bladder render that organ opaque to X rays. No concentration of bile takes place in the bile ducts so that shadows corresponding to them are not seen.

Very good results are usually obtained when the dye is given by mouth in the form of Opacol (May & Baker Ltd) or Shadocol (Kodak Ltd). The drug dissolved in water is given at 7 P.M. with a meal consisting of carbohydrate but no fat. No more food is taken, and next morning at 9 A.M.—i.e., fourteen hours after taking the drug—X ray films are taken of the gall bladder region. The patient then has a fatty meal, such as eggs and bacon, and two hours later a further X ray film is taken. The normal gall bladder is well visualised fourteen hours after the dye has been taken but the later film taken after the fatty meal usually shows the shadow to be definitely smaller or even absent owing to the gall bladder having emptied.

Alterations of the Gall Bladder Shadow in Disease—(1) There may be no shadow, (2) the shadow may be faint, (3) filling defects may be present, (4) the shape may be distorted, (5) the density may vary, or the time of appearance and disappearance of the shadow may be altered.

Interpretation—Should the hepatic or cystic duct be occluded or the gall bladder filled by stones no shadow will be visible. Fewer gall stones may give the shadow a mottled appearance. When the gall bladder fails to concentrate the



PLATE 23 —Non opaque (all stones showing as filling Defects in a Cholecystogram (From Plate 13 O A Marker)

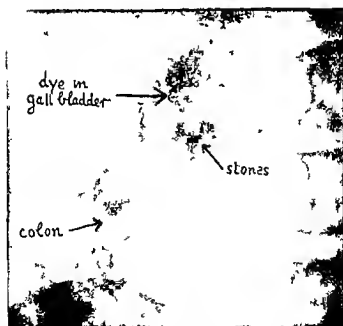


PLATE 24 —Gall bladder visualised by Cholecystography showing Stones. Some of the dye is also visible in colon (From X ray by Dr P J Briggs)

bile the shadow will be faint or absent. Adhesions or pressure from without will distort the outline.

Disadvantages—The presence of hepatic disease *contra* indicates the use of dyes owing to the danger of further injury. This includes cases with marked jaundice. Nausea, vomiting and diarrhoea may occur but if plenty of carbohydrate and water be taken with the drug these are not common.

Lyon's Test—The use of the duodenal tube in the investigation of gall bladder disease was introduced by Lyon. The general principle is the injection of a 25 per cent solution of magnesium sulphate into the duodenum. This produces as a rule a copious flow of bile a specimen of which is withdrawn through the tube. When gall stones are present the bile usually contains large numbers of cholesterol crystals. With cholecystitis microscopic examination of the bile shows the presence of pus cells and on cultivation there may be a growth of *Bacillus coli* or of streptococci. The conclusions formed as a result of this examination may be quite incorrect.

CARCINOMA OF THE BILE PASSAGES

Ætiology—Carcinoma may arise in any portion of the ducts or gall bladder but the gall bladder is much the most common site. Its greater incidence in women is in keeping with their greater susceptibility to gall stones. Gall stones are a common antecedent and are present in 70 to 90 per cent of gall bladder carcinomata.

Pathology—The fundus of the gall bladder is the usual site but carcinoma may start anywhere and if in proximity to the neck will obstruct the cystic duct. There may be a papillomatous outgrowth into the cavity of the bladder or a firm white infiltration of the wall. It is either columnar or spheroidal celled. Carcinoma of the bile ducts occurs most frequently in the lower end of the common bile duct or in the ampulla of Vater (ampulla of bile duct). The growth is columnar celled. Secondary growths may be found in the neighbouring lymph glands or liver.

Symptoms—Where carcinoma follows cholelithiasis there are preceding symptoms of gall stones or cholecystitis. The onset of malignancy may be accompanied by persistent pain in the right hypochondrium with flatulence and loss of appetite. The patients lose weight rapidly. A hard irregular tumour often appears below the costal margin directed towards the umbilicus and may reach large proportions. Tenderness is only moderate and rigidity of the right rectus not nearly as

marked as in inflammatory conditions. The liver may become involved from direct extension or metastatic growths.

In carcinoma of the common duct or ampulla of Vater there is a progressive obstructive jaundice (*vide p. 453*). The stools are acholic, the amount of pain is very variable, colic occurs, but there may be no freedom from pain in the intervals. The gall bladder becomes enlarged, and the liver is increased in size. The primary growth is not palpable, but some deep tenderness is present without marked rigidity. There is wasting and cachexia, and occasional slight fever. Ascites may ensue from peritonitis or pressure of enlarged glands in the portal fissure. Death results in a few months.

Diagnosis.—Carcinoma of the gall bladder is recognized when extensive, by the hard irregular tumour, with marked loss of weight occurring in an elderly patient with a history of gall stones. In empyema of the gall bladder, fever and leucocytosis are points of distinction.

The diagnosis of carcinoma of the common duct is more difficult. An important point of differentiation from gall stone obstruction is the distension of the gall bladder in the case of growth. Wasting and the absence of chills and fever are features of malignant stricture. Carcinoma of the head of the pancreas is usually painless throughout the course of the illness.

Treatment.—Symptomatic treatment is all that is possible, operative procedures being out of the question by the time diagnosis is possible. In cancer of the common duct or ampulla a cholecyst-duodenostomy may be done to relieve the obstructive jaundice.

DISEASES OF THE PANCREAS

Physiology.—The gland has two functions, the manufacture of insulin which is produced by the cells of the islands of Langerhans and the production, by the cells of the acini of the digestive ferments, lipase, trypsin, and diastase, which are excreted into the duodenum by way of the ducts of Wirsung (the pancreatic duct) and Santorini (the accessory pancreatic duct). The former joins the common bile duct to form the ampulla of Vater. The duct of Santorini is small and has a separate opening into the duodenum. The pancreatic secretion provides for the digestion of fats, proteins and carbohydrates and any diminution in the secretion is reflected in the character of the stools, though the disturbance must be considerable before this is evident.

Deficient pancreatic secretion renders the *faeces* bulky, pale, and oily, owing to an increase in their fat content. This condition is described as *steatorrhœa*. If, also, there be an interference with the passage of bile into the intestine, absorption of fats is still further hindered. On microscopic examination neutral fats and fatty acids are seen as droplets or needles, and there is also an increase in the number of undigested striated muscle fibres, a condition known as *azotorrhœa*. The fatty acids give the *faeces* a foul odour.

Diarrhœa is a constant accompaniment of *achylia pancreatica*, and may be very severe. There is no blood, but mucus may be present.

Laboratory methods for the detection of pancreatic insufficiency are not altogether satisfactory. Samples of the duodenal contents may be examined qualitatively for the presence of the pancreatic ferments but quantitative estimations are difficult. The determination of the fat content of the *feces* is also unsatisfactory. Perhaps the best test of pancreatic efficiency is the diastase index. This is based upon the fact that with obstruction of the pancreatic ducts diastase is absorbed into the blood and excreted in the urine. The latter normally contains 10 to 30 units of diastase, but with disease of the pancreas this figure may rise to 200 units.

ACUTE PANCREATITIS

Ætiology.—Previous or concomitant disease of the gall bladder with stones occurs in rather less than 50 per cent of cases. In all, the process is essentially that of the activation of trypsinogen into trypsin, resulting in self digestion of the pancreas. The agent producing this transformation is infected bile, normal bile or bacteria alone are not so active in this regard. Intestinal juice containing enterokinase will also produce widespread necrosis. It is possible that a duodenitis may be a preceding factor in some cases, especially in alcoholic individuals. Trauma with hæmorrhage may also be followed by acute pancreatitis.

Pathology.—Foreign substances ascending the pancreatic ducts will injure the pancreatic cells, and the chemical change activates the ferments, with the production of autolysis. The gland is swollen, reddened, and friable. Necrosis, gangrene, or suppuration may be seen in varying degrees, the activation of lipase produces fat necrosis, which is seen as opaque white areas in the neighbouring tissues, especially in the fat about

the pancreas and in the omentum. The lesser peritoneal sac may contain sero-hæmorrhagic fluid.

Symptoms—The typical attack is extremely severe. The onset is sudden, with intense pain in the epigastrium, often radiating to the left and going through to the back. It is usually a constant vice-like pain, but paroxysms of increased severity may occur. Vomiting begins soon after the pain and is persistent. The abdomen becomes distended and the condition may be mistaken for intestinal obstruction or acute peritonitis. The whole epigastrium is tender, but not markedly rigid. Deep palpation is possible, and occasionally a feeling of resistance is made out across the epigastrium, or the swollen head of the pancreas can be felt. The patient is obviously very severely ill from the onset, the skin is pale and moist, the temperature subnormal and the pulse rapid. Sudden loss of consciousness may even occur from shock. Glycosuria is uncommon, but the diastase index is high. A small quantity of blood-stained fluid may be found in the peritoneal cavity at operation. Death usually occurs on the third or fourth day.

Diagnosis—The severe pain, persistent vomiting, and general condition of shock associated with acute pancreatitis can rarely be distinguished with certainty from other conditions, such as perforation of a viscus or intestinal obstruction. Though acute pancreatitis may be suspected, the diagnosis is often uncertain until the abdomen is opened. Points which suggest the condition are acute tenderness in the epigastrium, with little or no rigidity. Fortunately, exact diagnosis is not essential, as the condition is one which calls for immediate operation and surgical drainage.

Suppurative Pancreatitis—Abscesses in the pancreas may occur in suppurative pylephlebitis, or as a sequel of a subacute hæmorrhagic pancreatitis.

CHRONIC PANCREATITIS

Ætiology and Pathology.—Chronic fibrosis of the pancreas of a mild degree may be found during the course of routine post mortem examination. Reports by surgeons that a chronic pancreatitis is present are often open to question, because palpation is difficult, and the size, shape, and consistency of the normal gland is subject to wide variations.

The commonest form of chronic pancreatitis is that characterised by an increase in the fibrous tissue between the lobules, and it is often associated with disease of the gall bladder. Infections of the duodenum, either as a simple

duodenitis or associated with an ulcer, may produce a similar condition. In spite of extreme fibrosis and atrophy of the gland, the islands of Langerhans remain unaffected. Another type of inflammatory change is an interacinar fibrosis with atrophy. This form is seen in some cases of diabetes and in the rare disease hemochromatosis in which deposition of iron containing pigment produces an interacinar fibrosis.

Symptoms—It is difficult to recognise cases of chronic interlobular pancreatitis as the symptoms and signs are indefinite but the enlarged head of the gland may sometimes be felt. Discovery of the condition is usually made during operations for gall stones or at post mortem. For these reasons little description of the clinical picture can be given.

Pancreatic pain is felt deep in the epigastrium towards the left side and in the back at the same level. The absence of pancreatic ferments in the intestine leads to stercorrhœa and steatorrhœa and the loss of fat produces marked wasting. Glycosuria is rare in interlobular pancreatitis. Jaundice may occur from the pressure of the fibrotic head of the pancreas on the common duct, but is usually due to coincident gall stones.

Diagnosis—The majority of cases in which chronic pancreatitis is likely to be suspected are those either of carcinoma of the head of the pancreas or of biliary tract disease. Practical experience shows that a diagnosis of chronic pancreatitis is frequently proved wrong by subsequent developments.

Treatment—Chronic cholecystitis and gall stones require cholecystectomy. Obstruction to the common bile duct by fibrosis of the head of the pancreas may be relieved by choledochostomy. The diet must be low in fats but carbohydrates are better tolerated. Pancreatin with 20 gr of calcium carbonate, should be given two hours after each meal.

CARCINOMA OF THE PANCREAS

Pathology—Carcinoma originates in the head of the pancreas in slightly over three quarters of the cases. It begins either in the ducts or in the acini forming a firm hard mass, often infiltrating the gland. Owing to the localisation of the tumour in the head of the pancreas glycosuria is uncommon. As the common bile duct (the bile duct) is always more or less embedded in the head of the pancreas it is usually obstructed as well as the pancreatic ducts.

Symptoms and Signs—Digestive disturbances such as nausea, anorexia abdominal discomfort, and vomiting are

common. Pain however is not a feature of the disease and in most cases is completely absent. When it occurs it is deeply seated in the epigastrium and extends into the back.

Jaundice progressing steadily to a deep olive green or black appearance is the most prominent symptom. Itching of the skin is often intense. The liver is usually not enlarged but the gall bladder is distended though not necessarily palpable. Throughout the course of the disease no tumour is palpable in two thirds of the cases and the diagnosis is difficult. The stools are clay coloured and fatty from the absence of bile but there is no free fat. Loss of weight and strength is rapid and cachexia soon follows. Death usually takes place four to six months from the beginning of symptoms.

Diagnosis—Progressive jaundice of obstructive type usually without pain in a patient who is past middle age is likely to be due to carcinoma either of the pancreas or of the common bile duct. Jaundice due to obstruction by a gall stone can usually be differentiated by a history of biliary colic and the non progressive character of the jaundice. An enlarged and palpable gall bladder associated with jaundice suggests growth of the pancreas rather than gall stone obstruction owing to the fact that in the latter condition the gall bladder is likely to be fibrotic. Catarrhal jaundice seldom occurs during the period of life in which carcinoma is common and the gradual disappearance of the jaundice together with the absence of emaciation and cachexia soon differentiate the conditions. Chronic pancreatitis associated with jaundice may be very confusing.

Treatment—The most distressing symptom is usually the intense itching which may render life intolerable. Fortunately this can always be relieved by cholecystenterostomy. The diet should be low in fats.

PANCREATIC CYSTS

Ætiology and Pathology—True pancreatic cysts are rare. More common are pseudo cysts formed by the collection of serous fluid in the lesser peritoneal sac by closure of the foramen of Winslow (aditus of lesser sac). Such cysts are often very large. They are not lined with epithelium the walls being formed of connective tissue. True pancreatic cysts are either retention cysts due to obstruction of a duct or cystic adenomata. The tail of the pancreas is the usual site. They are lined with epithelium derived from the pancreatic ducts or acini. In true cysts the fluid has a shimmering appearance is reddish brown

in colour, and contains degenerated cells, traces of pancreatic diastase, and often cholesterol crystals. Multiple small cysts may occur in conjunction with congenital polycystic disease of other organs, such as the liver and kidney.

Symptoms and Signs—The tumour due to the cyst is the most important sign. It is felt above the umbilicus in the midline or to the left under the costal margin extending to the midline. It may appear between the stomach and transverse colon, or between the lesser curvature of the stomach and the liver. The dullness on percussion may be continuous with that of the liver and spleen. The surface is smooth, with a rounded outline. If the tension of the contained fluid is not too great fluctuation can be elicited. The mass may be the size of an orange, or may almost fill the abdominal cavity. It may or may not move on respiration.

Pain is a variable feature, often there is none but occasionally colicky pain is felt in the epigastrium, even before a tumour is palpable. There may be radiation of the pain to the left.

Nausea and vomiting may be troublesome and account to some extent for the loss of weight and weakness. Glycosuria may occur, especially when the tail of the pancreas is involved. Symptoms may result from pressure on the common bile duct, portal vein or inferior vena cava. The enlargement is usually gradual, but hæmorrhage into the cyst may cause sudden increase in size with pain and slight fever.

Diagnosis—The occurrence of sudden changes in the cyst, such as hæmorrhage, may lead to its discovery.

A radiographic examination with a barium meal or enema will demonstrate the relation of the cyst to the stomach and colon. Without operation it is impossible to diagnose the type of cyst. In the differential diagnosis a distended gall bladder, mesenteric cyst, echinococcus cyst of the liver, hydro-nephrosis, and ovarian cyst must be distinguished.

Treatment—The cyst should be drained by operation. The patients usually do well, but recurrences are rather frequent. Occasional sequelæ to drainage are malignant degeneration in the wall of the cyst or the formation of calculi.

PANCREATIC CALCULI AND ADENOMATA

Pancreatic stones are exceedingly rare and are seldom diagnosed during life. Chronic infection of the pancreatic ducts is the probable cause. They are soft, greyish white in colour, and contain calcium. Owing to obstruction of the

duct, they occasionally give rise to colic, which may be mistaken for biliary colic. They are very opaque to X rays, but calcification within the pancreas may be misleading.

Treatment is unsatisfactory.

Adenomata of the cells of the Islets of Langerhans are rare. The tumour cells produce excessive quantities of insulin. The resulting clinical picture is one of chronic spontaneous hypoglycemia (vide p. 308).

DISEASES OF THE PERITONEUM

PERITONITIS

Inflammation of the peritoneum is caused by infection with micro organisms, occurring either primarily or, more commonly secondarily, following morbid processes in the contained viscera. The process may be generalised or local.

Ætiology—Primary Peritonitis—This somewhat rare form occurs as a terminal complication of gout, nephritis, and of any form of septicæmia. Also in this group are streptococcal and pneumococcal peritonitis, which though usually blood borne, are often without any obvious focus of origin.

Secondary Peritonitis—Inflammation of any of the organs within the abdominal cavity may lead to peritonitis, this however, is most commonly due to perforation of the appendix or a peptic ulcer.

Bacteriology—Peritonitis is usually a complication of pre-existing disease, and may result from any of the infections or other morbid conditions to which the abdominal and pelvic organs and the adjacent structures are subject. As might be expected, the bacteriology of peritonitis is very variable. The colon bacillus being a normal inhabitant of the gastro intestinal canal, and having great facility for migrating through the injured wall, is in consequence, frequently found in peritonitis. In the early stages it readily overgrows other organisms, and a pure culture is obtained. Later, however, it tends to die out. Various strains of streptococci are common. Infections with this organism occur sometimes in primary peritonitis and in that due to puerperal sepsis. The pneumococcus is found as part of a mixed infection but also sometimes as a primary or hæmatogenous infection. The gonococcus is frequently the cause of a local peritonitis and, more rarely, of a generalised peritoneal infection.

Pathology—In the earliest stage of a general peritonitis the peritoneal surface becomes dulled from congestion and

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oedema A serous and fibrinous exudation takes place and free fluid is found in the peritoneal cavity. The fibrinous exudate soon causes matting together of the organs, and the intestines ultimately become distended. The character of the exudate changes as the leucocytes increase until it may be thick and purulent. The particular organism predominating may determine the peculiarities of the exudation. In *Bacillus coli* infections the pus is thick, milky, and foul smelling. In virulent streptococcal peritonitis thin brownish fluid is found. In pneumococcal infection the pus is greenish and pseudo-membranous deposits may be seen.

In the healing process the exudate is either completely absorbed or there is organisation of the injured surfaces, so that firm fibrous adhesions are formed. The acute process may tend to become localised, especially when originating in the gall bladder, appendix or pelvic organs. Sudden perforation of a viscus spreads infection quickly over the whole peritoneal surface.

Acute Perforation of a Viscus—The majority of cases of general peritonitis result from the perforation of a hollow viscus and early diagnosis is of vital importance. The treatment is purely surgical, and the symptoms and signs of perforation are dealt with in textbooks of surgery.

Tuberculous Peritonitis—(Vide p. 133)

Pneumococcal Peritonitis—This is more frequent in children than in adults, and is usually independent of but may rarely be a complication of pneumonia. The predominance of this form of peritonitis in girls suggests infection by way of the genital tract, and a pneumococcal vaginitis has been shown to be present in many instances. A bacteraemia at the onset is demonstrable in half the cases. A pharyngitis may precede the peritoneal symptoms by two or three days. The onset is abrupt with high fever. Abdominal pain or vomiting may be the first symptom. The vomiting is persistent and may be projectile. Diarrhoea is constant at the onset, but later may be replaced by constipation. There is abdominal rigidity, general tenderness, and sometimes tympanites. The fever is high, but may show remissions. The leucocytosis exceeds 20 000 and often reaches 40 000.

The peritoneal exudate at first is thin and fibrinous and usually scanty, but becomes purulent and greenish in the later stages. It is most abundant in the pelvis.

The mortality among young children is very high, but between the ages of ten to fifteen recovery takes place in an increasing percentage.

a period of normal temperature lasting perhaps as long as two or three weeks before pyrexia returns. In the early stages the fever is often continuous or remittent, later it assumes the swinging septic type. The patient wastes and looks pale and toxic. In neglected cases he becomes grossly cachectic.

When fever is noticed and search fails to reveal a collection of pus elsewhere in the peritoneum (*e g*, pelvis), infection of the subphrenic region should be thought of. The patient may complain of pain in one or other side of the chest, often he will only admit to a slight discomfort when questioned. Occasionally there is a severe pleuritic pain. The anterior intra peritoneal abscesses can present below the costal margin where they form a palpable tender mass. The posterior ones may give rise to tenderness over the lower ribs, and there may be actual oedema of the skin and subcutaneous tissues, though this is generally too slight to be detected by other means than pinching up a fold of skin and comparing it with the skin over the lower ribs of the opposite side.

Abnormal physical signs are often present at the base of the corresponding lung, either due to compression of the lung or to an actual pleural effusion. The classical picture of alternating zones of resonance and dullness, from above downwards, due to a layer of gas in the abscess below the diaphragm, may sometimes be demonstrated. These abnormal physical signs in the chest may lead to a diagnosis of pneumonia or empyema, while the underlying subphrenic abscess is overlooked. In subphrenic abscess without an accompanying pleural effusion the heart is not displaced as it is in the case of a pleural collection.

It cannot be too strongly stressed that if a patient has suffered from an intra abdominal illness or operation and presents anomalous signs at the base of one lung, then a diagnosis of subphrenic abscess should be made and persisted in until every step has been taken to exclude it.

While the presence of a leucocytosis may confirm suspicion of the presence of pus, a figure below 10,000 per cubic millimetre is often seen in neglected cases, and therefore should not allay suspicions. The low figure is probably due to exhaustion of the bone marrow from severe toxic absorption. For the same reason a marked secondary anaemia is almost the rule in all but mild cases.

X ray examination helps by showing a raised and immobile diaphragm, which may also be deformed, sometimes a subphrenic fluid level due to the presence of gas and pus is seen. In cases where doubt exists as to whether aspirated fluid is

above or below the diaphragm, injection of some air, by giving a fluid level, will supply the answer.

In general, diagnostic needling to find a subphrenic collection is inadvisable, except as an immediate preliminary to operation, for infection of an uncontaminated pleura may readily follow. This pre operative needling in any case in which the presence of a subphrenic abscess is suspected should be systematic and thorough and should include both subphrenic regions.

Prognosis—Subphrenic abscess is always a serious condition, if not drained it carries a mortality of nearly 100 per cent. When drained the mortality is about 40 per cent. This is partly due to delay in diagnosis, partly due to the fact that it so often complicates an already serious abdominal condition such as late perforation of a viscus or appendicitis with diffuse peritonitis. The infection also readily spreads through the diaphragm and adds a chest lesion to the patient's other burdens.

Treatment.—Drainage should be provided as soon as the diagnosis is confirmed. In many cases this involves rib resection, and especial care should then be taken to avoid infection of the pleura. This may make a two stage operation necessary.

R. C. BROCK

ASCITES

Ætiology and Pathology.—The fluid may be a transudate or an exudate. The former occurs (1) in myocardial failure, (2) in portal obstruction, (3) as part of a general dropsy in chronic nephritis, (4) rarely in chronic severe anæmia.

Ascites due to exudation is seen in various forms of peritonitis, such as those due to tuberculosis or carcinoma.

The Character of the Fluid—The fluid in ascites due to transudation is clear and straw coloured with a specific gravity from 1010 to 1015, but not more. Its protein content is low and it contains endothelial cells and a few lymphocytes. When due to exudation the fluid may be turbid and the specific gravity is over 1015. The protein content is much higher than that of a transudate, and the cells are lymphocytes in larger numbers, together with a varying number of polymorphonuclear leucocytes depending on the degree of the peritoneal irritation.

In malignant peritonitis tumour cells sometimes, and red blood cells frequently, are present. In syphilitic liver disease the Wassermann reaction may be positive in the ascitic fluid. In tuberculous peritonitis tubercle bacilli cannot be found, but inoculation of a guinea-pig results in the development of tuberculosis.

The quantity of fluid varies, ranging from a few hundred cubic centimetres to many gallons

In *chylous ascites* the fluid contains fine fat globules but no leucocytes and appears yellowish white in colour. The specific gravity is usually above 1012. This condition is often associated with obstruction to the thoracic duct, which produces an escape of chyle from the lymphatics. A pseudo-chylous form also occurs in which the fluid contains only a small amount of fat in large globules and lecithin.

Symptoms—The enlargement of the abdomen is the most noticeable symptom. The gradual distension finally produces pressure symptoms, consisting of gastric disturbances, dyspnoea from elevation of the diaphragm, and oedema of the feet and legs from compression of the inferior vena cava. The urine may show albumen and casts for the same reason. The flanks bulge in the recumbent position. The skin becomes tight and shiny. The costal margins are everted and the respiration is largely thoracic. The heart is displaced upwards. On palpation a fluid thrill can sometimes be made out by placing the palm of one hand on one side of the abdomen and flicking the opposite side with the finger. An enlarged liver or other tumour can sometimes be felt by dipping down sharply through the fluid. On percussion there is a concave line of dullness curving around the sides and above the pubis. As the fluid increases the tympanitic central area becomes more and more limited until only the epigastric region under the xiphisternum remains tympanitic. The dullness will shift as the patient assumes different positions. When the ascites is considerable there is eversion of the umbilicus. Probably at least a litre of fluid must be present before it produces any signs.

Diagnosis—The commonest cause of difficulty in the diagnosis of the presence of ascites is extreme adiposity of the abdominal wall. An apparent fluid thrill conveyed by abdominal fat may be mistaken for the true thrill due to fluid in the peritoneal cavity. In these cases the presence of movable dullness must be the sign relied upon. With the patient in the knee elbow position the most dependent part of the abdomen will be dull on percussion if there be any ascites.

Large ovarian and parovarian cysts may simulate ascites very closely. In these the dull area is central and the flanks are tympanitic. A distended bladder can be distinguished by catheterisation. Large hydatid and pancreatic cysts should not offer much difficulty. The sudden onset of ascites always suggests portal thrombosis.

DISEASES OF THE CARDIO-VASCULAR SYSTEM

ANATOMY AND PHYSIOLOGY OF THE HEART

BEFORE considering the morbid changes that occur in the heart a brief account is required of its normal physiological activities

Close to the junction of right auricle (right atrium) and superior vena cava is to be found a small node of specialised neuromuscular tissue, about 2 cm long, lying close beneath the endocardium. Developmentally it represents a remnant of the primitive cardiac tube and is known as the *sino-auricular node* (also atrial node) of Keith and Flack (S A node). A similar mass of tissue, the *auriculo-ventricular* (also ventricular) node, lies beneath the endocardium of the right auricle about 1 cm above the interventricular septum (ventricular septum). A prolongation of this tissue passes downwards in the interauricular septum (atrial septum) to the top of the interventricular septum, where it divides to form the left and right branches of the *bundle of His*. These branches pursue a sub-endocardial course towards the apices of the ventricles, where they spread out to terminate in intimate connection with the musculature of the ventricular walls. This specialised tissue forms the only direct functional link between the muscle of the auricles and that of the ventricles, whereas part of the muscle of one auricle is continuous with that of the other, as is also the case in the ventricles.

Blood Supply of the Heart—All three layers of the heart are richly supplied with blood vessels. The main ventricular supply is through the right and left coronary arteries, which arise just above the anterior and left posterior aortic cusps respectively. They break up into a fine network of smaller vessels and ramify throughout the organ. The left coronary artery supplies the bulk of the left ventricle, the interventricular septum, a portion of the anterior surface of the right ventricle,

and the left auricle. The right coronary artery supplies the right auricle and the right ventricle, and a small part of the left ventricle.

During systole, owing to compression by the contracting muscle, the coronary flow ceases, and is resumed during diastole. Blood also reaches the intermuscular spaces from the ventricular cavity by way of channels known as the intertrabecular spaces or veins of Thebesius. In man their share in maintaining the circulation of the organ is probably greater than has hitherto been imagined. The anastomosis between the branches of the coronary arteries is limited, an anatomical consideration that emphasises the gravity of coronary occlusion.

Nerve Supply—A large number of fibres from the right vagus proceed directly to the sino auricular node. The cardiac fibres of the left vagus end near the auriculo ventricular node and the A V bundle, in which also nervous tissues are abundant. Fibres from the sympathetic system are distributed throughout the organ, the coronary vessels and the aorta.

MECHANISM OF THE HEART BEAT

Heart muscle is so constituted that any excitatory stimulus causing contraction of one fibre will be conducted to all other fibres with which it is connected by muscle tissue. Since cardiac muscle fibres are intimately connected so as to form a syncytium, it follows that an effective stimulus applied to one auricle will cause a wave of contraction to pass over all regions of both auricles. The same is true of the ventricles. Heart muscle invariably obeys the "all or none law," in that once excited it contracts to its fullest extent. It possesses a particularly long refractory period, so that anything in the nature of a tetanic contraction is impossible, individual contractions being separated by appreciable intervals.

The sino auricular node has been termed by Lewis the "pacemaker" of the heart and is a centre for the rhythmic production of a stimulus capable of exciting the surrounding auricle to contract. As the contraction begins at the S A node, which lies near the openings of the great veins, the closure of these is brought about by the shortening of the fibres encircling the orifices. The blood in the auricles is thus forced towards the still quiescent ventricles. When the wave of contraction reaches the A V node, the excitatory process is picked up by this tissue and passed on to the ventricular muscle by way of the A V bundle and its ramifications. Since the speed with which this junctional tissue conducts the impulse is relatively

high, the ventricular tissues contract very nearly simultaneously, the mitral and tricuspid valves close, and the blood is forced in the direction of the aortic and pulmonary vessels. The mitral and tricuspid cusps are prevented from being forced through the auriculo ventricular orifices by the action of the chordae tendineae. When the ventricles relax, the aortic and pulmonary cusps snap together, while the mitral and tricuspid valves open to admit auricular blood.

The time occupied by one complete beat followed by the period of rest is termed the cardiac cycle. Clinically, this is defined as the time between the beginnings of the first sounds in two successive normal beats. The cardiac cycle is in turn subdivided into systole and diastole. The former extends from the beginning of the first sound to the beginning of the second, and the latter from the beginning of the second sound to the next first sound. The heart of an adult beats normally between 60 and 80 times per minute, and at this rate the cardiac cycle occupies about $\frac{1}{3}$ sec. When cardiac muscle contracts it is said to be in systole, and when resting and relaxed, in diastole. Ventricular systole lasts about $\frac{1}{3}$ sec and diastole about $\frac{1}{3}$ sec when the rate is 72. The velocity of the pulse wave from the aorta to the wrist is such that the radial pulse becomes palpable nearly $\frac{1}{4}$ sec after the apex beat is felt. This fact is of importance when timing abnormal sounds or thrills, for conclusions as to whether a murmur is systolic or diastolic may be quite misleading when the radial pulse is used as a measure of systole. In timing murmurs systole is best gauged by palpation of the apex beat or the carotid pulse. It must be realised, however, that with a rapid heart action the character and pitch of an apical murmur provide the chief means whereby it can be defined as systolic or diastolic.

Cardiac Efficiency—A healthy heart has an ample reserve of power for the maintenance of the circulation under all conditions of strenuous exertion. In spite of popular opinion on the subject, there is little evidence that a healthy myocardium can be damaged permanently by strenuous physical exercise. Before this can occur, fatigue of nervous or skeletal tissues enforce the cessation of effort.

Under the influence of the teaching of Sir James Mackenzie, the importance of the functional efficiency of the heart muscle has been recognised. Whereas previously, undue stress was laid upon the presence of physical signs, particularly murmurs, in the estimation of the severity of cardiac conditions, to-day the reaction of the heart to exercise is regarded as the factor of prime importance. Many tests of cardiac efficiency are

advocated. Though differing in detail, they are all based on the fact that in health the heart rate is accelerated by exercise and rapidly returns to normal after the cessation of effort. The pulse is taken for 15 secs. with the patient standing. He then places one foot on a chair, the other being on the floor, and raises himself till both feet are on the chair, then lowers himself till one foot is on the floor. This is repeated twenty times in 60 secs. At the end of the exercise the pulse is taken for 15 secs. He then stands still for 45 secs. and the pulse is then taken again for 15 secs. This pulse reading should not be appreciable higher than the original resting rate. If during the exercise or immediately following it there are signs of undue dyspnoea and distress, cardiac efficiency is obviously impaired. Not uncommonly a patient's own story may be of as much or more value than an exercise tolerance test. Thus a walk from the station that formerly was not noticed may now produce breathlessness or a sense of distress.

It must be realised that all exercise tolerance tests, even in the case of healthy hearts, give results dependent on the training of the individual. Thus the trained athlete may be able to perform with ease an exercise which would overtax the capacity of an untrained man.

In healthy persons excessive exertion results in a marked increase in pulse-rate, and in rate and depth of respiration. In addition, there may be sweating and subjective symptoms of distress, such as palpitation and even precordial pain. This combination is known as the *physiological syndrome of effort*, and occurs in all individuals after what to them represents excessive exercise. Exertion which produces violent palpitation in an undersized clerk would hardly change the pulse-rate of a blacksmith. Hence in judging the exercise tolerance of an individual it is important to take into account his life and habits.

PHYSICAL SIGNS OF THE NORMAL HEART

The physical signs of the heart vary with change of posture, and it is a good rule, whenever possible, to examine patients standing up, lying down, and *lying on the left side*. Exercise and respiration also influence the character of the cardiac sounds. The following is a brief summary of the findings based on the examination of a large number of normal hearts.

Inspection.—On inspection, there is symmetry of the left and right halves of the thorax, and no precordial bulging.

A maximal cardiac impulse, corresponding with the apex of the left ventricle and the left border of the heart, may be observed in adults usually in the fifth but sometimes in the sixth left interspace from 7.5 to 11.5 cm (3 to 4½ in) from the mid sternal line, according to the build of the individual. The visible impulse may be limited to an area of the size of a shilling or it may be diffuse over a large area and even reach the epigastrium. Frequently it is completely absent. *The apex impulse is the most reliable physical sign we possess of the position of the left border of the heart.* Its position should always be defined as so far from the mid line. Visible pulsation may also occur normally at the second right and third left interspaces. The position of the apex impulse varies with posture, and when the patient lies on his left side it moves towards the axilla for a distance of about an inch. The veins of the neck are hardly visible in the upright position but may bulge and pulsate visibly when the subject is supine.

Palpation—When the impulse is diffuse, the region of maximum thrust may be taken as the apex beat. Sometimes when there is a diffuse impulse and particularly during rapid heart action, there may be a sensation of a coarse vibration over the entire precordium during systole.

In children the apex beat may be higher than in adults and is sometimes found in the fourth space. The mid clavicular line should be regarded as only a rough guide to the normal limits of the left border.

Percussion—Percussion is of relatively little value in determining the position of the left border of the heart. This organ is overlapped by the left lung to a variable extent, which seriously interferes with percussion, especially in patients of middle age and over. If the apex beat is not palpable or visible the size of the heart can only be defined with certainty by means of an X ray examination. Normally, there is no impairment of note to the right of the sternum, if there is, the impairment is due to the right auricle. Anatomically, the right border of the heart is mainly right auricle and the left border mainly left ventricle, whereas almost the entire portion of the heart covered by the precordium is right ventricle which is partly covered by lung to a depth that varies with respiration.

The Heart Sounds—To simplify classification of heart sounds the precordium is divided into four areas: the *aortic area* at the second intercostal space to the right of the sternum, the *pulmonary area* at the third interspace on the left border of the sternum, the *mitral area* roughly corresponding with

the region of the apex beat and a little internal to it, and the *tricuspid* area at the sixth right costosternal junction and lower end of the sternum. Over these areas are best heard the normal sounds originating at the corresponding valvular orifices.

In the majority of normal subjects the only sounds heard over the precordium are the first and second heart sounds. In a fair percentage of persons, however, in whom there is no discoverable disease of heart or lungs other sounds may be occasionally heard. Among these are blowing sounds or murmurs varying in intensity, heard best at one or other area and *always* systolic in time. They may vary with posture and the respiratory movements, or disappear and reappear for no obvious cause. They are often described as cardio-respiratory murmurs. The first or second sound may be reduplicated. Whenever such additional sounds are heard, they should suggest a specially careful examination of the cardio-vascular system for evidence of disease but should not in themselves be taken to indicate a structural change.

If the stethoscope be placed over a large superficial artery nothing is heard unless the vessel be compressed when an intermittent blowing sound simultaneous with the pulse is audible. Such a murmur is sometimes encountered during auscultation below the outer end of the clavicles and is obviously of no pathological significance.

Normal Sensations referred to the Precordium—The majority of persons are not conscious of their heart beat, except some times after exercise, when the physiological response to effort is present. Those of a highly excitable temperament or emotional instability may be abnormally conscious of their thoracic and abdominal viscera, the heart particularly, although a careful examination reveals no evidence of organic disease. In such subjects rapid heart action and palpitations are to be regarded as of nervous origin and not as signs of a diseased heart.

PHYSICAL SIGNS SUGGESTING CARDIAC DISEASE

Unfortunately, specific structural changes do not always lead to specific physical signs that would render diagnosis a straightforward and simple matter, indeed conspicuous anatomical changes may occur without giving rise to specific physical signs, and be discovered only at autopsy. In general, however, it may be said that the presence of certain well recognised physical signs is not only pathognomonic of cardiac

damage but signals damage of a definite character. The most important of these is cardiac enlargement.

Enlargement of the Heart—The most certain indication of organic heart disease is cardiac enlargement. This is true whether the increase in size is due to hypertrophy or dilatation. Cardiac enlargement known to have been of rapid onset and short duration suggests dilatation perhaps complicated by a pericardial effusion. Persistent enlargement present for several months suggests that hypertrophy is probably a factor. In a heart known to have been enlarged for many months but more or less stationary in size, it is not possible to assess how much of the enlargement is due to hypertrophy and how much to dilatation. Nor is it of prognostic import to differentiate between them. All that is necessary is to remember that *while all diseased hearts are not enlarged yet all unquestionably enlarged hearts are diseased*. So dogmatic a statement as this raises the question whether there is in the case of the heart, no such process as a purely physiological hypertrophy in response to increased work over a considerable period such for example as occurs without any evidence of disease in one kidney after the other is removed. From available data the conclusion seems inevitable that enlargement of the organ that can be detected clinically is never to be regarded as of a physiological or healthy origin. Healthy men who have lived physically strenuous lives such as athletes and manual labourers do not show clinical cardiac enlargement in the absence of coincident disorder referable to the cardio vascular or renal systems though there may be a slight increase in the weight of the heart. Insurance statistics also show that the expectation of life is diminished in persons with enlarged hearts and no other signs or symptoms of disease.

We may thus conclude that chronic enlargement is the result of chronic disease whether progressive or arrested and that acute enlargement heralds an acute condition whether due to fatigue, anaemia or inflammation of the myocardium.

Precordial Thrills and Cardiac Murmurs—By a thrill is meant a vibration of the thoracic wall felt over the cardiac area and communicated to the hand during palpation. It is always accompanied by a murmur though the converse is not true. Murmurs (*bruits*) may be high pitched and blowing or low pitched and rumbling and sometimes may have a musical quality. They occur at any period of the cardiac cycle. They may precede, lead up to or follow the usual heart sound or replace one or other of these entirely. They may be loud and readily audible distant and faint or vary in intensity.

The significance of a cardiac murmur is often a difficult problem. As a general principle it may be said that all diastolic murmurs indicate organic disease. Systolic murmurs on the contrary do not necessarily imply any pathological condition. To reach a decision as to the significance of a systolic murmur it is necessary to take into account many factors, such as the age of the patient, the possibility of congenital heart disease, his record as regards previous diseases, particularly rheumatic fever and syphilis and any other abnormal physical signs found in the examination of the heart. Provided the patient is under middle age, has no history of rheumatic fever or syphilis, has a good exercise tolerance and displays no other physical signs of cardiac disease it is generally safe to assume that a systolic murmur, whatever its site or distribution is of no pathological significance. It is not uncommon to find at autopsy no structural abnormality of the heart or great vessels when during life a loud systolic murmur has been present.

Systolic murmurs may alter in character or intensity with change in posture and with different phases of respiration. Such murmurs are often termed cardio-respiratory and are of no pathological significance. Sometimes in diseases affecting the lung, such as pneumonia, abnormal sounds synchronous with cardiac systole may be heard. These are described as oxocardial murmurs or sometimes as pleuro-pericardial friction sounds. They have no special significance.

Apart from the systolic murmurs so often heard in apparently normal hearts, particularly when the pulse rate is high they are heard also in the following conditions —

- 1 Cardiac enlargement acute or chronic
- 2 Valvular disease, acquired or congenital, and patent ductus arteriosus
- 3 Dilatation of the aorta or aneurysm
- 4 Atheromatous changes in the valves
- 5 Hyperthyroidism
- 6 Anæmia
- 7 Convalescence from acute infections

A systolic murmur developing in the course of rheumatic fever may be the first sign of a mitral endocarditis. Where there is underlying structural alteration in the heart or great vessels, systolic murmurs are usually uninfluenced by posture and the respiratory phase. The association of a thrill with a murmur is usually indicative of organic change.

It is important to realise that auscultatory findings form only part of the evidence on which a particular diagnosis is based. The entire clinical picture is the only safe basis on which to found the final conclusion ætiology being always of extreme importance. The types of murmur associated with lesions of individual valves are discussed in the section dealing with chronic valvular disease (*vide* p. 529).

DISTURBANCES OF RATE AND RHYTHM

When the heart is beating normally, the stimulus initiating contraction arises in the S A node. A contraction may, however, follow a stimulus originating elsewhere in the myocardium and such a beat is often spoken of as *ectopic* in origin.

The rate of origin of normal stimuli arising in the S A node is under the influence of the vagus nerve, vagal stimulation leading to slowing. Stimulation of the sympathetic accelerates the heart rate, but its action is incompletely understood. Ectopic foci may exist anywhere in the heart muscle, and give rise to isolated beats, or to a series of regular beats for varying periods of time. Particularly is this the case when there is active disease. The passage of an excitatory impulse, wherever it may arise, may be interrupted in its course by so-called "block" in the junctional tissues, or by meeting a portion of muscle still in the refractory state. These simple principles form the basis of our knowledge of irregularities of the heart beat. Before describing in detail the commoner irregularities a brief account of the instrumental means employed for their exact analysis will be given.

The Polygraph—This instrument records simultaneously the radial pulse and the venous and arterial pulsations at the base of the neck. The pressure in the jugular veins is closely related to the pressures in the right auricle, and that in the carotids to the pressures in the left ventricle. At the present time the polygraph has been almost completely replaced by the electrocardiograph.

The Electrocardiograph—Einthoven, in 1903, devised an extremely sensitive galvanometer on the principle of a fine metal plated quartz fibre or "string" (2μ in diameter) suspended in a powerful magnetic field. Movements of the fibre are magnified many hundreds of times and photographed on a moving film or plate. The position of the string at a particular instant is related to the current flowing through it.

at that time. It has long been known that muscular contractions are associated with variations in electrical potential. Einthoven devised his instrument to utilise this fact. By connecting the fibre to two points on the body surface it is possible to obtain well marked deflections of the string with each contraction of the heart. Moreover the form of the deflection or electrocardiogram as it is called is closely related to the course of the excitatory process in the myocardium. This instrument is in extensive use; it seldom affords much information of value in valvular disease but is decisive in the elucidation of obscure arrhythmias. In suspected myocardial disease in elderly patients and in all cases of thoracic pain the electrocardiographic findings are important. A brief description of electrocardiographic findings will be appended in the following sections. A normal electrocardiogram is shown in Fig. 8.

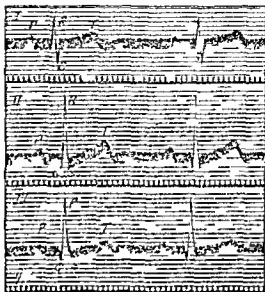


FIG. 8 — Electrocardiograms from the Three Leads in a normal subject to illustrate the change in the type of curve with change of lead. Note that R is tallest in Lead II.

(From *Clinical Electrocardiography* by S. Thomas Lewis.)

The small deflection P is associated with the excitation of the auricles and the deflections Q, R, S and T with excitation of the ventricles. The interval between the beginning of P and the summit of R is regarded as the time taken for the wave of excitation to travel from the S.A. node to the ventricular muscle. This P-R interval is related to the conducting capacity of the junctional tissues and in the normal heart does not exceed 0.20 sec. Electrocardiography has grown to be almost a separate branch of the study of heart disease and an enormous literature has accumulated. For ordinary clinical work Einthoven adopted the leads: Right Arm—Left Arm=lead I, Right Arm—Left Leg=lead II, Left Arm—Left Leg=lead III. These leads are now in general use.

Recently an effort has been made to explore the electrical field round the heart by contacts placed close to this organ, and a new lead, so called Lead IV, is coming into use. In this one contact is placed on the chest wall just outside the position of the apex beat and the other is on the right arm (Lead IV R) or left leg (Lead IV F), usually the latter. This lead has only recently been standardised, and though it is certainly of value in research and sometimes provides conclusive evidence of coronary infarction or pulmonary embolism where the other leads fail to do so it is still uncertain if this happens frequently enough to justify the extra complications of its routine use for clinical purposes.

TACHYCARDIA AND BRADYCARDIA

By tachycardia is meant a conspicuous increase in the heart rate with or without disturbance of rhythm. It may continue for long periods or may be limited in duration to a few hours or even a few seconds.

A simple tachycardia is present when the stimulus production in the S A node is increased in frequency above the normal rate for the individual in question, and when it is not characterised by an abrupt onset and an equally abrupt cessation. The latter characteristics define a special form of irregularity of rhythm to be described later, namely, *paroxysmal* tachycardia. Simple tachycardia is the physiological response to exercise, excitement, fear, and emotion. It also commonly accompanies any of the following conditions: (1) Pyrexia, when the pulse rate increases roughly by 10 for every 1° F rise in temperature; (2) convalescence from debilitating disorders; (3) anemia; (4) disease of the heart muscle; (5) hyperthyroidism; (6) hysteria; the menopause; (7) pregnancy; (8) intoxication with drugs such as alcohol, tobacco, atropine, and thyroid extract.

Simple tachycardia is a symptom of some underlying condition, and disappears when this is removed. It seldom exceeds 130 beats per minute for long, when it does so, the heart's action may become seriously embarrassed and this leads to distressing symptoms. In simple tachycardia the pulse rate is influenced by changes in posture, it is also increased by the action of atropine on the vagal nerve endings. On the other hand, in paroxysmal tachycardia, or that due to flutter of the auricles, variations in posture and administration of atropine are without effect on the pulse rate. In the condition known as the "effort syndrome" (*vide p. 567*), the

tachycardia is simple in type, but may be complicated by extra systoles. In early phthisis prolonged tachycardia may be one of the earliest physical signs. In acute rheumatic infections, persistent tachycardia may be the only sign of a serious cardiac involvement necessitating prolonged rest in bed until the pulse rate has returned to normal.

In simple tachycardia the electrocardiograph reveals normal auricular and ventricular complexes with, if anything, a shortening of the P R interval.

Bradycardia—Heart rates below 70 are common both in health and disease. A heart rate of 40 or below is, however, suggestive of some degree of heart block (*vide p 507*). Rates between 40 and 60 are often encountered in young healthy athletes, during convalescence from acute illness during and after jaundice, in conditions involving cerebral compression and in 2 to 1 heart block.

Abnormally low pulse rates due to non transmission of the ventricular beat to the wrist, as in digitalis poisoning with pulsus bigeminus (*vide p 314*), do not constitute true bradycardia.

SINUS ARRHYTHMIA

In a certain number of young adults, and very commonly in children the pulse rate shows periodic waxing and waning. These variations are related to the respiratory movements, the rate increasing during inspiration and slowing during expiration. This relationship may often be demonstrated by the request to breathe deeply. This so called sinus arrhythmia is due to changes in the rate of origin of impulses in the S A node and is under vagal control. It is presumably a reflex from the vagal terminations in the lungs. During convalescence after fevers it is often specially noticeable. Pulse irregularity obviously related to the respiratory movement is without pathological significance.

Other Sinus Irregularities—In some people the heart rate varies under vagal influence without relation to the respiratory movements. A common example of this condition is the ordinary syncopal attack or 'fainting fit' in apparently healthy individuals, when the heart rate may drop to 50 and is accompanied by a sudden fall in blood pressure. The condition is specially common in persons showing the "effort syndrome". Sometimes the feeling of sudden faintness may develop into actual loss of consciousness. All sinus irregularities disappear under the influence of atropine, exercise, amyl nitrite, and fever.

EXTRA SYSTOLES

When the heart contracts following an impulse arising outside the S A node the contraction is described as an extra systole or premature beat. These may thus originate in the muscle of either auricles or ventricles and are described as auricular or ventricular extra systoles. They may occur singly and at long intervals scattered frequently throughout an otherwise regular rhythm in runs of twos and threes or as in paroxysmal tachycardia in a continuous stream persisting for a considerable period. A ventricular extra systole is followed by prolonged compensatory pause as the ventricle is refractory to the next impulse transmitted from the auricle. With an auricular extra systole this pause does not occur as the following impulse from the S A node is sufficiently delayed to allow the ventricle to pass out of its refractory period. Examples of auricular and ventricular extra systoles are shown in Figs 9 10 and 11. When extra systoles alternate with normal beats they give rise to the so called pulsus bigeminus a rhythm characteristic of digitalis poisoning.

Extra systoles occur at all ages and under all conditions but their incidence is greatest after fifty years of age. They may be present without any evidence of myocardial disease. When the heart is diseased however they tend to be frequent. They are associated with the excessive use of tobacco and will sometimes cease on omission of the drug. By themselves i.e. unaccompanied by cardiac enlargement degenerated arteries tachycardia valvular disease or other signs and symptoms suggesting myocarditis they are without significance. If they occur after or during an attack of chorea or rheumatic fever or if present along with other and definite evidence of cardiac damage they may be regarded as almost certainly allied in some way to an underlying inflammation. Not uncommonly they constitute the only clinical warning of an active process invading the myocardium. For example the persistence of extra systoles following an attack of scarlet fever or diphtheritic infection should suggest a prolongation of convalescence until the premature beats are absent or relatively infrequent.

Extra systoles are recognised clinically either by auscultation or by palpation of the radial pulse. They produce irregularity in the pulse both in volume and in rate. When very frequent the irregularity may simulate closely the type of pulse met with during auricular fibrillation or flutter of the auricles. The rate is important in this connection. In

heart rates of over 120 per minute extra systoles are rare whereas in fibrillation and flutter the irregularity persists when the pulse is raised above 120. This fact provides a simple clinical method of distinguishing between extra systoles and fibrillation or flutter, mild exercise sufficient to increase the heart rate to 120, will usually abolish the irregularity when.

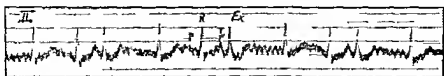


FIG. 9 — Lead II Auricular Extra systoles arising near the Sino auricular Node with hardly any compensatory pause. The Extra systoles occur each third beat giving Pulsus Trigeminus

(From ECG by Dr Maurice Campbell)

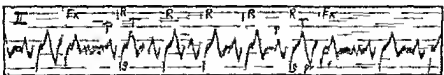


FIG. 10 — Lead II Auricular Extra systoles arising in the Auricle some way from the Sino auricular Node and spreading backwards through the Auricle as shown by the inverted P waves with each premature beat

(From ECG by Dr Maurice Campbell)

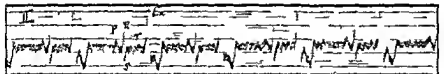


FIG. 11 — Lead II Ventricular Extra systoles arising after each normal beat giving Pulsus Bigeminus. In Figs 9 and 10 the premature ventricular beats have the same form as the normal beats because the impulse has spread down the A V bundle in the normal way. With Ventricular Extra systoles this is not the case

(From ECG by Dr Maurice Campbell)

extra systoles are responsible but as the heart rate falls again the irregularity may be intensified. In cases of fibrillation or flutter exercise will aggravate rather than abolish the irregularity. In persons predisposed to premature beats fatigue tends to increase their frequency particularly during the period of slow pulse and bodily fatigue following excessive exertion. If extra systoles occur during tachycardia they are an indication of toxic myocarditis.

The character of the heart sounds during an extra-systole will depend on the precise point during diastole at which the extra beat occurs. Should it, for example, occur when the ventricles are comparatively empty, the pulmonary and aortic valves may not open and consequently there will be only a first sound and no second sound to accompany the extra beat nor will there be any associated pulse wave at the wrist. Frequent extra systoles may thus give rise to a deficiency in the pulse rate as compared with the ventricular rate in the same way as during fibrillation. It should be borne in mind that auricular fibrillation is occasionally preceded by frequent extra systoles for a considerable period.

Extra systoles do not give rise to any special symptoms and may pass unnoticed by the patient. In nervous individuals however anxiety may result from the sensation of a 'thump' or 'shock' in the chest that is occasionally felt to follow a premature beat. Normal individuals when resting quietly may sometimes be conscious of an isolated extra systole. When however, they occur in paroxysms which frequently recur or continue for long periods distress may be marked.

PAROXYSMAL TACHYCARDIA

This term is applied to tachycardia of limited duration characterised by an abrupt onset and an equally abrupt cessation. It is due to a regular sequence of impulses arising in an ectopic focus in the heart muscle such a focus may be in the auricles, A V node or ventricles. In the two former the condition is known as *auricular or nodal paroxysmal tachycardia* in the last as *ventricular paroxysmal tachycardia*. In all the tachycardia is really a series of extra systoles.

Ætiology—Paroxysmal tachycardia of auricular or nodal origin is relatively common. In a large series studied recently more than half occurred in otherwise healthy persons without demonstrable evidence of cardiac distress. In many it was still true that the heart appeared normal after the paroxysms had been present for twenty to forty years. Even where there was heart disease the patients often did well for long periods. Paroxysmal ventricular tachycardia on the other hand occurs chiefly in association with congestive failure or coronary occlusion. Sometimes it may be brought about by excessive doses of digitalis. The prognosis is generally more serious even apart from the associated heart disease. Fortunately it is much less common, and the patient with it is generally

already under observation because of the condition of the heart. The following description refers only to the more common disorder, namely, the auricular and nodal type

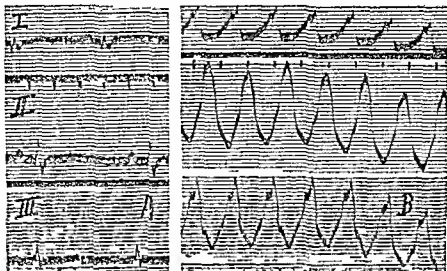


FIG 12

Ventricular Tachycardia rate 203 (auricular activity hidden), from a man with myocardial disease. Tracing A normal rhythm. B, ventricular tachycardia.

Symptomatology.—The heart rate during a paroxysm remains remarkably steady at a given level for a given individual. The rates commonly vary between 150 and 200, but may exceptionally be as low as 140 or as high as 240. The ventricles beat at the same rate as the auricles. The pulse rate during a paroxysm is uninfluenced by changes in posture. An attack may be associated with no unpleasant sensations beyond a fluttering in the chest or throat or it may give rise to profound distress, including pain over the precordium, a feeling of fullness and distension in the abdomen, flatulent dyspepsia, nausea and even vomiting, great fatigue and attacks of fainting. In prolonged attacks the patient becomes cyanosed, and in due course all the signs of severe congestive failure may develop. The severity of symptoms depends on the degree to which the blood pressure falls and the extent of cardiac dilatation.

Paroxysms may occur at long intervals of months or years, or may recur at intervals of days or hours. An attack may last from a few seconds to ten days. In a recent investigation the usual duration of the paroxysms was more often hours than days, but one third of the patients had paroxysms lasting

more than a day, 10 per cent rarely, 10 per cent often, and 10 per cent habitually. They may come on without warning at any time, or be precipitated by a heavy meal, excitement or other trivial event. A paroxysm ceases abruptly either spontaneously or following change of position of the body, placing the head between the knees, pressing on the eyeballs, holding the breath under pressure, or the act of vomiting. Lewis states that deep pressure below the angle of the jaw over one or other of the carotid arteries, when maintained for 10 to 20 sec, sometimes stops an attack through a reflex of the carotid sinus. Many tricks of sudden movement (*e g*, bending down to open a low drawer) may stop an attack, perhaps a forced expiration with a closed glottis after a deep inspiration is the most generally successful. No measure proves equally efficient in every case, though the same measure is often successful in an individual patient.

The more frequent and prolonged the attacks, the worse the anxiety and distress, a paroxysm lasting more than a few days usually results in severe prostration. If during the free periods, the cardio vascular system is apparently sound and the exercise tolerance high and provided the paroxysms are short and infrequent, the prognosis remains good. With evidence of myocardial damage during normal rhythm such as generalised arteriosclerosis cardiac enlargement valvular disease and frequent prostrating attacks, the outlook is poor. For though sudden death in an attack is a rare event, frequent attacks superimposed upon an already damaged myocardium must surely increase the rate of myocardial deterioration.

Treatment—When the paroxysm occurs in a patient who is otherwise healthy, one of the simple procedures described above may sometimes suffice to terminate it.

Paroxysmal tachycardia is a symptom rather than a disease. In a minority of patients chiefly with ventricular paroxysmal tachycardia it accompanies serious heart disease and the prognosis then is grave. In most patients paroxysmal tachycardia is not in itself of any grave significance. It is due to reflex causes more often than to any primary change in the heart muscle. This applies not only to the majority whose hearts are otherwise normal but to most of those with rheumatic heart disease and to some with other myocardial disease. In some of the rheumatic cases and less often in others, paroxysms of fibrillation may alternate with or replace paroxysms of tachycardia. In the rheumatic cases established fibrillation then becomes a possibility in the near future.

The prognosis of paroxysmal tachycardia as regards life

is therefore excellent, unless it is of the rare ventricular type, unless appearing relatively late in life and as the first indication of disease of the coronary arteries, or unless before the paroxysms have started there is already serious heart disease.

During an attack rest should generally be advised, but rest in bed is not needed unless special symptoms, or the condition of the heart at other times, make it advisable. If an attack persists towards evening, bed, with a sedative or hypnotic, will generally lead to its arrest. Quinidine, 5 gr., repeated if necessary in two hours, is probably the most useful medicinal treatment. The cessation of attacks after digitalis has often been reported, but it is doubtful if it is effective and generally it should not be given unless indicated by the state of the heart apart from the paroxysms, or by the development of failure in a long attack. Of newer remedies mechoyl (acetyl β methyl choline), 15 mgm intramuscularly or intravenously, is sometimes successful, but is unpleasant. So far prostigmin, 0.5 mgm subcutaneously, has seemed more effective and harmless to use, but it is early to decide its special indications and limitations. Morphine is not desirable in ordinary recurrent attacks.

After the paroxysm the most important question is to determine the condition of the heart. If thorough examination justifies it, reassurance about the nature of the attacks is often all that is called for, and this alone will sometimes greatly diminish their incidence. The general regulation of the patient's life as regards food, work, and exercise must next be attended to, and in many cases a sedative, such as bromide, will be all else that is needed. If, in spite of this, the attacks are frequent and troublesome, regular administration of quinidine for a time 3 to 5 gr t.i.d., will often succeed.

Differential Diagnosis—A regular pulse rate of 160 or over, paroxysmal in character, is nearly always an indication of paroxysmal tachycardia. In auricular flutter and fibrillation the pulse rate is usually lower, and in the case of fibrillation there is in addition a striking irregularity. In doubtful cases an electrocardiogram is decisive.

HEART BLOCK

In heart block the power of the conducting tissues to transmit impulses is impaired. Thus there may be a delay in the passage of the impulse from auricles to ventricles, or, if the block is more severe, only a fraction of the auricular contractions reach the ventricular muscle, in complete block.

no auricular beats reach the ventricles, and auricles and ventricles beat independently. The electrocardiograph reveals minor degrees of block which may be clinically unrecognisable, in such cases a prolongation of the P R interval beyond the normal limits (0.20 sec.) is the diagnostic feature.

Heart block is invariably associated with damage to the auriculo ventricular bundle. In young patients the cause is usually a rheumatic or diphtheritic inflammation, or, less commonly, an attack of tonsillitis but a few instances of heart block of congenital origin have been described. In elderly persons it is due to some form of chronic myocarditis, most often with atherosclerosis. In both groups autopsy reveals lesions in the junctional tissues, in elderly persons particularly, the bundle may be found to be sclerosed, calcified, interrupted by a gumma or neoplasm, or otherwise involved in some gross lesion.

In slight degrees of block isolated auricular beats may fail to stimulate the ventricles, thus giving rise to the so called "dropped beat". This must be distinguished from an extra systole, in which condition there may be no pulse at the wrist, although the ventricle contracts. In pulsus bigeminus alternate extra systoles fail to come through to the pulse at the wrist. The condition is often due to digitalis poisoning and is frequently mistaken for the much more serious condition of heart block.

When alternate auricular contractions are followed by ventricular responses, we speak of a 2:1 block. This condition is suggested clinically when the pulse rate is observed suddenly to become halved or doubled. 2:1 block is an unstable rhythm, readily disappearing under the influence of excitement, mild exercise, and certain drugs. It is sometimes met with in hyperthyroidism. The preceding examples are known as partial block, for the ventricles are not completely cut off from the auricles. In complete block the two sets of chambers beat independently, the ventricles contracting at their own characteristic rate of below 40. When the heart rate is persistently below 35, it is almost certain that complete dissociation has occurred. In complete block the pulse is regular, of good volume, and unaffected by posture, exercise, or drugs influencing the heart rate, such as amyl nitrite and atropine. Faint muffled sounds representing the auricular beats may be heard in the prolonged diastole, and when ventricles and auricles beat synchronously an unusually loud first sound is heard. In the same way when auricular systole falls near the first or second sounds, reduplication or

accentuation of either of these may be heard. The electrocardiogram (Fig 13) shows clearly the complete dissociation between P (auricular) and Q, R, S, T (ventricular) complexes.

Since heart block is merely one sequel to a widespread lesion, the symptoms in such cases are those of a progressive myocardial disorder. Although there are many instances on record where patients with complete block have carried on a useful life for many years without unpleasant symptoms,



FIG 13—A Curve of Complete Heart Block or Dissociation of the Auricular and Ventricular Rhythms. The auricles and the ventricles are beating regularly but at the independent rates of 78 and 29 respectively.

(From *Clinical Electrocardiography* by Sir Thomas Lewis)

the prognosis is usually poor. It is not the heart block that destroys the patient but the inevitable cardiac failure eventually resulting from the concomitant myocardial damage and the grave risks arising from Stokes Adams attacks.

Stokes-Adams Syndrome—It occasionally happens, and especially during the transitional stage between partial and complete block, that the ventricles fail to beat for a considerable period or contract at rates (below 10 per minute) insufficient to maintain an adequate cerebral circulation. Syncopal attacks preceded by dizziness ensue, or, when there is prolonged diastole, transient unconsciousness and convulsions. Sometimes sudden death occurs. Such attacks are to be distinguished from major epilepsy, which they may closely resemble; they are, however, very much shorter in duration. The characteristic slow pulse should settle the diagnosis.

The treatment of heart block, whether partial, complete, or complicated by Stokes Adams attacks, calls for no special measures beyond those required for chronic heart disease (*vide p 553*). Adrenalin (5 to 10 m of a 1 in 1,000 soln hypodermically), ephedrine ($\frac{1}{2}$ gr t d s) and perhaps barium chloride ($\frac{1}{2}$ to 1 gr t d s) are said, however, to prevent attacks.

AURICULAR FLUTTER

Auricular flutter is a condition in which the auricles beat at a much increased rate in a highly abnormal manner.

Lewis concludes from his experimental work that in flutter "the contraction wave follows a circular and never ending path in the annule, the complete circuits being accurately repeated usually from 260 320 times per minute in different subjects" The diagnosis is difficult on clinical examination alone, but may be suspected when a rapid heart rate persists at an extremely regular rate for longer than would be expected with paroxysmal tachycardia, or when the heart appears fast and regular at one moment and completely irregular a moment later. An electrocardiogram shows the increase in the rate of the auricular contractions by the presence of an increased number of P waves. In flutter, the ventricles rarely contract at the same rate as the auricles, and it is usual to find some degree of heart block reducing the ventricular rate to some simple fraction of the auricular, such as $\frac{1}{2}$, or, less commonly, $\frac{1}{4}$. In about one third of the cases the degree of heart block is frequently changing and the heart rate is then irregular and is very hard to distinguish from auricular fibrillation.

Nothing is known of the underlying cause. Flutter may occur at any age, but is most commonly observed during or after middle life. The usual aetiological factors are a rheumatic history, syphilis of the cardio vascular system, septic foci in the alimentary or urinary tracts, persistent high blood pressure with or without renal disease or atheroma of the coronary arteries. Almost invariably there is other evidence of myocardial involvement such as a low exercise tolerance, murmurs, and cardiac enlargement.

Symptoms and Diagnosis—Auricular flutter occurs in paroxysms, or may persist for life unless it change to fibrillation under the influence of digitalis. The symptoms of paroxysmal flutter and paroxysmal tachycardia are very similar. The ventricular rate in flutter is seldom as rapid as in paroxysmal tachycardia and is usually between 130 and 160. When the patient is at rest it may fall conspicuously and become noticeably irregular.

Occasionally instances of persistent flutter show little discomfort but this is rare. Patients with a poor exercise tolerance during normal rhythm are much upset by the onset of flutter and evidence of rapid congestive failure may arise. When ever the ventricles take on the full auricular rate, a rare event profound distress or even unconsciousness may supervene.

Prognosis and Treatment—The prognosis, as in almost all cardiac disorders depends on the condition of the myocardium. The presence of arteriosclerosis, valvular disease, high blood pressure, and other complications such as nephritis or anaemia,

must all be taken into account. Treatment should be directed towards minimising the work of the heart. The drug of choice is digitalis, to which properly administered, there are no contraindications. Under its influence, the flutter may continue without change, or give way to fibrillation. On omitting the drug, the fibrillation may cease and be replaced by normal rhythm. When the flutter persists, digitalis slows the pulse with marked benefit. If digitalis fails to restore normal rhythm and if the case is otherwise suitable (see p. 515) quinidine should be tried and may be effective. If congestive failure is present, the patient must, of course, be confined to bed and suitable measures employed.

AURICULAR FIBRILLATION

With the exception of extra systoles auricular fibrillation is the most common of the arrhythmias and it is by far the most important. It is a condition in which there is no synchronised and orderly contraction of the auricular muscle. Individual groups of muscle fibres contract intermittently frequently, and independently. Lewis ascribes the condition to a wave of contraction coursing continuously, and by different paths, round the auricle at a rate of over 400 cycles per minute thus differing only in degree from the allied condition of flutter. The fibrillating auricles dilate and do not contribute to the passage of blood into the ventricles. This dilatation occasionally leads to intra auricular clotting, with grave danger of embolism. Should a clot become detached from the right auricle, a branch of the pulmonary artery may become blocked and cause sudden death or infarction of the lung (*vide* p. 587). Emboli from the left auricle lodge in the arterial system, not uncommonly in the brain. Disasters of this kind are especially liable when fibrillation suddenly gives way to normal mechanism the first forcible contraction of the auricles dislodging a portion of the clot (see also Contraindications to Quinidine, p. 515).

The junctional tissues fail to transmit to the ventricle the great majority of the auricular impulses, only a fraction are effective in producing ventricular contractions which occur at irregular intervals. It is assumed that in all cases of fibrillation there is some degree of heart block, and it is by increasing this block that digitalis produces its beneficial effect in slowing the ventricular rate.

Ætiology—Auricular fibrillation, whether paroxysmal or permanent, may be a feature of almost any form of heart

disease. Before middle age its incidence is greatest as a sequel of *rheumatic carditis*, and it is particularly common in patients with mitral stenosis. Rarely seen before sixteen years of age, its incidence rises with age, and when congestive failure occurs in the subjects of rheumatic heart disease, fibrillation is excessively common. In later life, however, it is a common complication of any form of myocardial insufficiency, particularly that due to the fibroid and fatty changes associated with generalised arteriosclerosis, chronic nephritis, and disease of the coronary vessels. Hyperthyroidism is a particularly important factor in the causation of fibrillation, and should be suspected in all unexplained cases after middle age. In a small percentage of cases paroxysmal fibrillation may occur without obvious cause.

Diagnosis and Symptoms.—Fibrillation may be either paroxysmal or permanent. Paroxysmal attacks seldom persist for more than three or four days, and the longer the individual attacks last, the greater the probability of fibrillation becoming permanently established. As a general rule, an attack continuing for a week is likely to continue indefinitely unless terminated by quinidine. Rarely in acute infections such as pneumonia or cystitis there may be an isolated paroxysm of fibrillation, which is usually of short duration.

The onset of fibrillation is sometimes preceded by frequent extra-systoles, and a careful watch is necessary to detect the change over from one arrhythmia to the other. The important and characteristic feature of this condition is the complete irregularity of the pulse both in volume and rhythm. This irregularity is usually detected with ease, except when the pulse-rate is unusually low and the heart beats evenly spaced. When the pulse is both rapid and irregular, fibrillation should always be suspected. When it supervenes in a heart with mitral stenosis, the typical crescendo presystolic murmur in the majority of cases disappears, and a low-pitched rumbling diastolic murmur remains to indicate the stenosis. Since the auricles do not contribute to the blood flow into the ventricles, the ventricular output is related to the length of the diastolic pause. After a particularly short diastole there may be insufficient blood in the left ventricle to produce a pulse in the radial artery, hence the characteristic *pulse deficit*, i.e., the difference between the pulse-rate at the wrist and the heart rate as counted over the precordium. The electrocardiogram displays no recognisable P waves, and the Q, R, S waves are unequally spaced (see Fig. 14).

As in all cardiac disease, the symptoms depend mainly on

the efficiency of the myocardium, which is much reduced by an excessive rate due to fibrillation of the auricles. Patients with fibrillation and a normal pulse-rate may remain in fairly good health for a long time, even up to ten or more years, and it is only when the myocardium fails or the heart rate rises that signs of distress appear. It is noteworthy how seldom fibrillation is accompanied by cardiac pain. In a large number of persons dying of progressive cardiac failure, fibrillation of the auricles appears sooner or later, and unexpectedly sudden

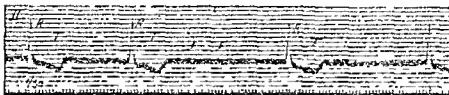


FIG. 11.—From a case of Fibrillation under treatment with Digitalis. It shows irregularity of the ventricle and inversion of T. The oscillations are small; P does not appear.

(From "Clinical Electrocardiography," by Sir Thomas Lewis)

death may perhaps be due to the fibrillation spreading to the ventricles. The differential diagnosis of auricular fibrillation and frequent extra-systoles has been discussed on p. 503.

Treatment and Prognosis.—The reputation of digitalis as a cardiac tonic was derived from its efficiency in the treatment of fibrillation. By its action in diminishing the conductivity of the bundle of His, the ventricles are shielded from the frequent and irregular impulses originating in ectopic foci in the auricles. Their rate slows down, the coronary circulation improves, and the efficiency of the myocardium is enhanced with marked improvement in the circulation. Under its influence in cases of advanced failure the output of urine is greatly increased, dyspnoea diminishes, cyanosis becomes rapidly less marked, and mental symptoms disappear. In acute failure digoxin (*vide* p. 515) has largely replaced strophanthin; it may be given intravenously and after an interval digitalis should be pushed to its full physiological effect.

There is no evidence that digitalis can cause fibrillation to revert to a normal mechanism. Quinidine, on the other hand, in a proportion of cases of established fibrillation, quite definitely brings about a sudden change to normal rhythm, but only a small proportion of cases are suitable for this treatment (*vide* p. 515).

Many cases of established fibrillation have been observed for a great many years, without apparent deterioration. Their exercise tolerance, however, remains consistently low. Such persons are best kept on small doses of digitalis, suitably spaced to keep the ventricular rate at an optimum level.

Whereas in established fibrillation, treatment with digitalis should always be tried it must be remembered that in paroxysmal fibrillation its effect may be to render the arrhythmia permanent. Except in the rare cases where this is desirable, digitalis should be avoided and an attempt made to terminate the paroxysms by means of quinidine, which may have to be given over a long period (*vide p. 116*). Most paroxysms of fibrillation, however, cease without treatment, but quinidine given regularly in doses of 5 gr. thrice daily, may assist in diminishing the frequency of attacks or lead to their total disappearance.

Administration of Digitalis and Quinidine—The effect of digitalis on any tachycardia except that due to auricular fibrillation is doubtful. It is frequently prescribed with alleged good results in many conditions associated with an acute or chronic myocarditis. It is, however, chiefly in auricular fibrillation with tachycardia that its value is outstanding.

The guide to the dosage of digitalis is the heart rate and the relief of symptoms. Its administration should aim at keeping this at an optimum level in the region of 70 to 80. When the rate falls below this level, symptoms of intoxication such as nausea, vomiting, diarrhoea and headache may appear. The *pulsus bigeminus* in which every alternate contraction is an extra systole, is characteristic of digitalis poisoning and the appearance of coupled beats is always an indication to withhold the drug which has a cumulative action. In feverish patients it is unwise to reduce the pulse rate below 90 to 100, slight tachycardia being a normal accompaniment of pyrexia. To continue the drug in the face of warning signs may lead to sudden death from direct cardiac poisoning.

Dosage—Most preparations of digitalis are standardised by biological assay in terms of international units. Powdered digitalis leaf (1 gr.) and tincture of digitalis (10 minims) are equivalent according to this standard but there is so much variation in each patient mainly owing to the different amounts that can be excreted in twenty-four hours by the kidneys that the correct dosage has to be found in each case. Difficulties also arise because many days elapse before an effective concentration in the blood is reached with most preparations of digitalis and the amount that can safely be given to an ill

patient who has not had any previously is very different from the amount that is needed regularly.

When a patient who has not been given digitalis has auricular fibrillation and congestive failure or other indications for digitalis therapy, it may be urgent to get him under control within as few hours as possible, and for this purpose massive digitalisation was introduced, but owing to the risks of this treatment it is generally better, since the introduction of digoxin, to use this drug, and 1.5 mg by mouth or 0.75 mg intravenously is recommended in such cases. This is safer than massive digitalisation with the tincture and safer and much more effective than intravenous strophanthin, with the latter the effective dose and the toxic dose are so close that it is often difficult to get any useful control without producing vomiting.

When it is less urgent to get full control at the earliest possible moment or when a small dose of digitalis has been given ineffectively, a single dose of 1 to 1½ drachms of the tincture may be given, followed six hours later by 20 minims t.i.d. until the full effect is obtained. Small doses may then suffice and be carried on over long periods. When a patient has been fully digitalised the object is to find the optimum maintenance dose, i.e., enough to get the best possible control of the heart without giving rise to toxic symptoms. The authors have found in practice that M12½ of a good tincture, or 1 gr. of powdered digitalis leaves, 0.25 mgm digoxin, or 0.06 gr. of Nativello's digitaline may be taken as equivalent, and in an average case the dose needed is this amount three times a day. It will be noted that these equivalents found useful clinically are not quite the same as those quoted from pharmacological standardisation on animals. There are, of course many preparations nearly or quite as good, but the important thing is that the practitioner should confine himself to a small number of digitalis preparations so that he can become really familiar with them. It is still not realised universally that in fibrillation digitalis generally needs to be continued for the rest of the patient's life.

Some patients show an idiosyncrasy to digitalis, as shown by vomiting after small doses. In this event Nativello's digitaline may be better tolerated.

Quinidine may be used in an attempt to abolish fibrillation, providing the following contraindications have been excluded —

(a) Idiosyncrasy to the drug, as shown by distressing symptoms, such as vomiting and tachycardia, following an initial trial dose of gr. vi.

(b) The presence of venous engorgement or congestive failure as shown by cyanosis œdema enlarged liver, or dyspnoea

(c) A history of continuous fibrillation for six months or over

(d) Considerable enlargement of the heart

(e) A history of recent hæmoptysis and pleurisy suggesting pulmonary embolism of intracardiac origin or a history of a systemic embolism e.g. in attack of hemiplegia

Quinidine has an important place in the treatment of auricular fibrillation—provided the cases are carefully selected. The ordinary patient seen in hospital is quite unsuitable, the risk is too great and if fibrillation is arrested it generally returns soon. Satisfactory results are obtained by paying attention to three main criteria: the absence of congestive failure of a greatly enlarged heart or of a long history of fibrillation.

The case is eminently suitable for treatment with quinidine and should certainly be given this opportunity of regaining normal rhythm if there have been no signs of failure and if the heart is only slightly enlarged (less than 13 cm. maximum transverse diameter in a patient of about 10 st.) and if fibrillation has been established less than one month.

The case is not suitable if there has been gross congestive failure or if any signs of failure persist after treatment with rest and digitalis or if the heart is greatly enlarged (more than 14 cm. maximum transverse diameter in a patient of about 10 st.) or if fibrillation has been established for six months. The presence of any one of these three usually means that treatment with digitalis should be preferred. In intermediate cases the decision will be made according to how nearly they fall into one or other of these groups.

When there is mitral stenosis these conditions must be strictly observed. Least attention need be paid to them if fibrillation is due to a goitre as if necessary partial thyroidectomy will convert an unfavourable case into one favourable for quinidine.

On the first day of treatment with quinidine one 5 gr. tablet is given, preferably in the morning. On each successive day an additional 5 gr. is given two hours after the previous dose but the amount should rarely exceed a total of 30 gr. in twenty-four hours. The drug is best given in 5 gr. doses at two hourly intervals owing to the fact that it is very rapidly excreted. A careful watch must be kept for signs of poisoning as evidenced by an untoward increase in the ventricular rate. There is no knowing how long normal rhythm may continue

when it does appear. In many cases the quinidine is without effect. Rarely fibrillation will revert to normal rhythm within a few hours of a single dose.

PULSUS ALTERNANS

When the radial pulse is alternately weak and strong though regular in time, it is described as *pulsus alternans*. It is to be distinguished from an alternate weak and strong pulse, separated by shorter and longer intervals, that is characteristic of alternate extra systoles *i.e.*, the *pulsus bigeminus*. *Pulsus alternans* may be readily felt on ordinary palpation but its character is best demonstrated by slowly inflating the sphygmomanometer cuff and observing that, at a certain critical level, the pulse at the wrist becomes exactly halved. Pulse tracings also demonstrate its alternating character. The electrocardiogram shows either nothing of note or, rarely, a corresponding alternation in the amplitude of the R waves. The importance of the phenomenon lies in the fact that it is frequently associated with advanced myocardial disease with an ominous prognosis.

It is often observed in association with high pulse rates, as in simple paroxysmal tachycardia, when found at ordinary rates, persistent high blood pressure, arteriosclerosis, renal disease, or angina pectoris are usually present, and it is often noticeable with gallop rhythm (*vide p. 540*). Rarely it is seen in digitalis therapy with large doses.

CARDITIS

By the term *carditis* is meant an inflammatory process involving the myocardium, pericardium and endocardium. Although obvious morbid changes may not be present throughout all the tissues of the heart there is in most cases more than a localised lesion of one particular portion. Thus rheumatic pericarditis is always associated with some degree of myocarditis, and endocarditis does not arise as a separate entity apart from damage to the myocardium. It is therefore permissible to employ the term *carditis* in a wide sense to imply an inflammation of the heart, whether it involves the myocardium alone, or in addition the endocardium and pericardium.

In such a sense *carditis* is an accompaniment of, and sometimes the most important feature in, a number of infections, including especially rheumatic fever and diphtheria, and less

commonly scarlet fever and pneumonia. Of these needless to say rheumatic fever is by far the most common and important though in any severe infective process such as a septicæmia the extent of cardiac damage is often the deciding factor in prognosis.

Although carditis in a mild degree probably accompanies most general infections or toxæmias our knowledge of the morbid changes associated with the condition in its early and milder stages is necessarily limited by the fact that recovery usually takes place and it is only in the more severe grades of carditis that there is any opportunity for study of the process from its anatomical and histological aspects.

From the clinical point of view carditis as the result of acute infections is far more common among children than among adults and in rheumatic fever it may sometimes be the only obvious manifestation of the disease. Moreover as carditis is frequently associated with some infective process elsewhere it is often overlooked as the symptoms of cardiac involvement may be overshadowed by those of the disease which is producing it. When the heart muscle is chiefly involved there may be little in the way of physical signs and the diagnosis of carditis may have to rest chiefly upon symptoms and the probability of its occurrence.

Having emphasised the fact that there is a close relationship between all inflammatory processes which involve the various tissues of the heart it is now permissible to deal individually with affections of the muscle, the pericardium and the endocardium. Of these perhaps the most important is myocarditis as it is primarily upon the adequate functioning of the heart muscle that life depends. Moreover in every inflammatory condition of the heart the myocardium is invariably affected.

ACUTE MYOCARDITIS

The pathological changes found in myocarditis have been mainly studied in acute rheumatism. The most striking gross change is enlargement of the heart particularly of the ventricles thus the heart may be found to be both larger and heavier than normal. As a result of the process of dilatation the auriculo ventricular orifices are wider than normal. Histological examination shows localised collections of large branching cells with multiple nuclei and an admixture of lymphocytic cells. These are termed *Aschoff's bodies* or submiliary nodes and occur in the heart muscle around the smaller arterioles.

particularly under the endocardium and the pericardium. In other infections such as diphtheria or scarlet fever the changes are not so characteristic as in rheumatic fever but the muscle cells show evidence of an acute inflammatory process with infiltration of round cells and leucocytes.

It has already been pointed out that myocarditis produces no typical physical signs. Displacement of the apex beat to the left will indicate increasing enlargement and the apex beat may become diffuse. The first sound may change in quality and become fainter often a point of considerable diagnostic importance. A systolic murmur is often present. Sometimes too there is an absence of symptoms and the heart may have been considered to be unaffected until sudden failure occurs sometimes even during convalescence. In some cases involvement of the myocardium may be suggested by persistent tachycardia by various arrhythmias such as extra systoles or occasionally by bradycardia. In severe myocarditis sudden death may occur or there may be symptoms of congestive cardiac failure with cyanosis oedema and dyspnoea. The recognition of myocarditis is of extreme importance and in the infections which are specially liable to attack the heart great care must be taken to allow an adequate period of rest.

PERICARDITIS

Rheumatic pericarditis is relatively rare and its occurrence always signifies grave involvement of the myocardium. Apart from rheumatic fever it may arise in pneumonia and septic infections such as osteomyelitis and pyæmia. In the young acute rheumatism and osteomyelitis are the chief causes but it also occurs in older persons as a terminal infection in chronic diseases particularly nephritis. Pericarditis is often a feature of infarction of the myocardium. Both tuberculous and malignant pericarditis are uncommon they are often associated with a blood stained effusion.

Pericarditis may or may not be accompanied by an effusion but there is no justification for drawing any sharp distinction between a simple fibrinous pericarditis and that in which there is also a pericardial effusion as the basic pathological process is similar although the physical signs produced are very different. The normal smooth glistening surface of the pericardium becomes roughened by the exudation of lymph which coagulates and forms a fibrinous layer over the heart. The process may

involve only localised areas in the pericardium but frequently it is more generalised, in the milder cases there is little or no effusion, but often the pericardium becomes gradually distended with fluid which may be serous blood stained seropurulent or purulent. When pericarditis is extensive, the pericardium is very much thickened with a rough and shaggy surface. If the patient survives the acute stage organisation of the coagulated lymph takes place and the visceral and parietal layers of the pericardium may become firmly adherent together, and thus produce the condition known as adherent pericardium.

Physical Signs and Symptoms of Pericarditis—Pericarditis occurs secondarily to disease elsewhere in the body, and often the symptoms are overshadowed by those of the primary disease. Thus is specially true in the terminal pericarditis associated with chronic nephritis when it is not uncommon to find unsuspected pericarditis at autopsy. The onset of pericarditis may be associated with precordial pain which is often aggravated by coughing deep breathing or movement. With pericardial effusion dyspnoea restlessness and insomnia are often marked features. The distress is more striking when the effusion has collected rapidly. When the effusion is purulent as in pyæmia, the skin is ash grey in colour, and the patient is obviously extremely ill.

On physical examination in the early stages, the heart is found to be enlarged, and occasionally fremitus may be felt, a friction rub is heard which is to and fro in character, corresponding with systole and diastole. The intensity of the rub varies considerably in individual cases, and from time to time in the same case. It is harsher and more grating in character than a to and fro valvular murmur sounds close to the ear and often becomes louder on pressing the stethoscope firmly against the chest. As rheumatic pericarditis occurs mainly in severe carditis there is necessarily an associated involvement of the heart muscle.

With the development of a pericardial effusion there is a marked change in the physical signs, a rub previously audible over the whole precordial area may disappear completely as the layers of the pericardium become separated by fluid. More often however, it may still be heard over the base of the heart when the patient is examined lying down as the fluid gravitates to the back of the pericardial sac. The area of cardiac dullness is increased and, with a large effusion, assumes a characteristic pear shaped form with the apex pointing upwards. The dull area extends to the right of the sternum and tends to fill up the cardio hepatic angle. The apex beat

becomes more diffuse or may disappear completely and the sounds become muffled and indistinct. The pericardial note over a pericardial effusion is very dull and board like thus resembling that heard over a pleural effusion. In cases of doubt an X ray examination is of great value. The heart shadow occupies a median position in the thorax and the shadow cast to the right of the spine is often as large as that on the left side. With the fluorescent screen pulsation is absent with a pericardial effusion whereas with enlargement due to dilatation and hypertrophy it is more easily visible than usual.

The presence of a pericardial effusion may be established by exploratory puncture. The most satisfactory site is a point in the fifth left interspace about 1 in. internal to the outer limit of the cardiac dullness. A wide needle is used and is inserted slowly unattached to a syringe. If the needle comes in contact with the heart this will usually become immediately apparent by the movement of the needle with each cardiac systole. Most physicians must however at some time have had the somewhat alarming experience of exploring the cavity of the ventricle while attempting paracentesis of the pericardium. There is no difficulty in the recognition of such an accident as blood spurts out through the needle at each heart beat. Strange to relate even when pierced by a needle the heart usually continues beating normally and on withdrawal the muscle of the ventricle immediately closes the perforation.

Treatment of Pericarditis—There is but little evidence that the older remedies for pericarditis such as the application of leeches or ice bags have any material effect. In view of the inflammation of the heart absolute rest with good nursing is of prime importance. When a large effusion is present particularly if it has accumulated rapidly the heart's action is embarrassed and paracentesis must be performed. Usually the withdrawal of several hundred cubic centimetres of fluid gives marked relief. With a purulent effusion recourse must be had to surgical drainage. This is particularly important in cases associated with pneumonia or osteomyelitis. When pain is severe morphia is required.

Prognosis—In pericarditis of rheumatic origin the prognosis depends on the associated damage to the heart muscle and valves and complete recovery is unusual. On the other hand in pericarditis associated with osteomyelitis and pyaemia the heart muscle is much less affected and if the patient survives the ultimate outlook is good.

ADHERENT PERICARDIUM

Following acute pericarditis adhesions may form between the visceral and parietal layers of the pericardium and the cavity becomes obliterated. Unfortunately in many cases the process extends still further and adhesions are formed between the pericardium and neighbouring structures such as the mediastinum the pleura the diaphragm and the chest wall. In such an event the heart usually remains greatly enlarged after the subsidence of the acute inflammatory process and it therefore has to carry on its work at a great mechanical disadvantage.

Adherent pericardium is most commonly met with in patients who have had several severe attacks of rheumatic fever and in addition to the adherent pericardium chronic valvular disease is often present. Sooner or later the heart muscle fails and congestive failure ensues.

Physical Signs of Adherent Pericardium—On inspection the apex beat is diffuse and is situated considerably more to the left than normal. Bulging of the chest wall is often apparent over the precordium and at each systole there is retraction of the intercostal spaces or even of the lower end of the sternum. Sometimes a systolic retraction of the eleventh and twelfth ribs may be noticed when the patient is viewed from behind in a good light (*Broadbent's sign*). On palpation fixity of the apex beat is apparent even when the patient is turned on his left side. The pulse may become weaker during inspiration (*pulsus paradoxus*). On percussion and auscultation there are no characteristic findings though the heart is always much enlarged and in all probability murmurs are present.

Adherent pericardium is often diagnosed clinically and at autopsy found to be absent as a very enlarged heart often gives similar signs. No single physical sign is pathognomonic of the condition and it is rash to make the diagnosis in the absence of marked cardiac enlargement and a history of pericarditis or at least of rheumatic fever.

The outlook with adherent pericardium is poor and medical treatment is of little avail. Attempts have been made to deal with the condition surgically but as might be expected the operative mortality in such cases is very high.

Constrictive Pericarditis—Thickening adherence and sometimes even calcification of the pericardium may obstruct the inflow of blood into the heart from the venous side. This may give rise to enlargement of the liver with ascites dyspnoea

and oedema of the feet. The condition is not associated with a history of rheumatic infection and often the heart is not much enlarged. The condition is sometimes known as Pick's disease. Cases have been successfully treated by surgical resection of pericardial adhesions.

ENDOCARDITIS

By the term endocarditis is meant an inflammatory condition affecting the lining membrane of the cavity of the heart occasionally the endocardium covering the muscular wall of the heart is involved and such a condition is described as *mural endocarditis* but more often the inflammatory process is confined to those folds of the endocardium which form the valves. Endocarditis involving only the valves on the right side of the heart is rare apart from congenital heart disease.

Much confusion has arisen as regards the nomenclature of endocarditis owing to the fact that terms are often used in different senses by various authors. All forms of endocarditis are almost certainly infective yet the term infective endocarditis is often limited to a special type characterised by ulceration of the valves and multiple embolic phenomena. This special type is best described under the heading of bacterial endocarditis.

From a clinical and pathological point of view endocarditis may be grouped into five types —

1 Simple endocarditis almost always due to rheumatic infection and part of a general carditis.

2 Acute bacterial endocarditis which is due to infection by the staphylococcus *Streptococcus hemolyticus* pneumococcus gonococcus or other organisms.

3 Subacute bacterial endocarditis due to the *Streptococcus viridans*.

4 Syphilitic aortitis spreading to the aortic valve and rarely to the anterior cusp of the mitral valve.

5 Tuberculous endocarditis consisting of endocardial milium tubercles (very rare).

In simple endocarditis no micro organisms can be cultivated from the valves and there is a tendency toward the development of chronic fibrotic changes. The second type acute bacterial endocarditis which is always fatal is but one manifestation of a general acute septicæmic process due to invasion of the blood by bacteria. The third type subacute

bacterial endocarditis is midway between the other two in so far that attempts at healing may sometimes occur, and it is nearly always associated with one specific type of organism the *Streptococcus viridans*.

Before attempting separate descriptions of these three types of endocarditis it is necessary to emphasise certain features which are common to all three varieties. It has already been stated that endocarditis affects mainly the valves on the left side of the heart except in congenital heart disease. The tricuspid valve however, is often found to be involved in conjunction with a mitral and aortic endocarditis.

The earliest pathological changes in endocarditis are the formation of small elevated areas along the line of closure of the valves these are known as vegetations. In the simple or rheumatic type these vegetations are generally small as a rule a few millimetres in diameter, but in acute and subacute bacterial endocarditis they are often large and friable. The vegetations are composed of blood platelets and fibrin deposited upon the swollen endothelium, sometimes it is possible to isolate micro organisms from the vegetations but in many cases and always in simple endocarditis blood culture is negative and no organisms can be recovered from the local lesions. It may be assumed that toxins produced elsewhere may lead to degenerative changes in the valve and as a result to the deposition of fibrin from the blood.

SIMPLE ENDOCARDITIS

Acute rheumatism accounts for the great majority of cases of chronic valvular disease which result from acute endocarditis. It is true that sometimes patients with evidence of endocarditis are encountered who give no history of either rheumatism or chorea but in such cases it must be remembered that the joint manifestations of acute rheumatism in childhood may be readily overlooked. Indeed rheumatic carditis is not uncommon without obvious joint symptoms. It is possible however that other infections particularly scarlet fever or repeated attacks of tonsillitis may produce an endocarditis resembling that produced by rheumatic infection.

In simple endocarditis associated with rheumatic fever microscopical examination of the deeper part of the affected valves reveals the presence of aggregations of cells similar to those described in the cardiac muscle under the term Aschoff's bodies. With the subsidence of the acute infection the vegetations become the seat of a process of slow fibroid change

continuing for many years. This results in the valve segments becoming deformed producing incompetence or stenosis.

Symptoms and Signs of Simple Endocarditis—It has already been stated that endocarditis is but one aspect of a carditis and that its presence implies associated myocarditis and sometimes pericarditis. It is not surprising therefore to find that any symptoms due to endocarditis are usually overshadowed by those referable to the inflammation of the heart as a whole. In other words the diagnosis of endocarditis is necessarily speculative in the earlier stages of an illness such as rheumatic fever and its occurrence may only be definitely proved by the development at a later stage of chronic valvular disease. Certain physical signs may however be present and either prove or suggest the presence of valvular involvement. Thus the detection of an early diastolic murmur over the base of the heart or down the sides of the sternum is definite evidence of an aortic valvular lesion. A decision as to involvement of the mitral valve is not however equally easy. It has already been pointed out that in many normal persons systolic murmurs are frequently heard in the absence of mitral disease. A systolic murmur at the apex may be produced by a widening of the mitral ring resulting from dilatation of the left ventricle such as may occur in any form of myocarditis. It is difficult to distinguish a murmur so produced from one associated with the presence of actual vegetations on the valve cusps. Often indeed the ultimate decision must be left in abeyance until the development of other signs of a mitral lesion prove the valve cusps to be involved. It is sometimes stated that apical systolic murmurs due to simple dilatation of the heart are more localised than those due to mitral endocarditis whereas those due to the latter condition are likely to be propagated into the axilla. This however is not always true. Although therefore the development of an apical systolic murmur even in the course of rheumatic fever cannot be regarded as definite evidence of a valvular lesion it must necessarily be viewed with grave suspicion and is an indication for prolonged and complete rest.

Mitral endocarditis should never be diagnosed on the strength of a systolic murmur alone. Enlargement of the heart however associated with a systolic murmur strongly suggests that the valve has not escaped. An erroneous diagnosis of organic heart disease may affect irreparably the well being of the patient in that exercise and the normal activities of life may be unnecessarily restricted. It must be remembered that apical systolic murmurs are often heard in perfectly healthy persons. Such murmurs are not necessarily localised to the

apex but may be propagated into the axilla or even heard at the angle of the left scapula. Their main characteristic is the variation in the murmur which occurs with respiration and change in posture. As a rule the murmur tends to become weaker or to disappear completely during expiration though during the inspiratory phase it may be loud and blowing in character.

As simple endocarditis is merely one manifestation of a carditis it calls for no special treatment apart from that necessary in any case where inflammation of the heart is present. In acute rheumatic endocarditis embolism is rare though it occurs frequently in chronic valvular disease particularly when auricular fibrillation or subacute bacterial endocarditis are present.

ACUTE BACTERIAL ENDOCARDITIS

In this type of endocarditis vegetations are found upon the valves as a result of a general blood infection with varying types of organism such as pneumococci streptococci staphylococci or gonococci. The involvement of the valves is but one feature of a more generalised bacterial invasion of the tissues and is often but a terminal manifestation. In contrast to simple or rheumatic endocarditis it is usually easy to isolate micro organisms from the vegetations after death and blood culture during life is often positive. The size of the vegetations varies from minute pinpoint elevations along the line of closure of the valves to large and friable masses from which emboli may be shed into the blood stream. There may be much ulceration and destruction of the affected valves which may be perforated. Abscesses may occur in the heart muscle adjoining the vegetations. Frequently the presence of such an endocarditis is unsuspected until the valves are examined after death but sometimes when the vegetations become large there may be evidence of their presence in the development of valvular murmurs or embolic phenomena. As a rule the mitral and aortic valves are chiefly affected. Unlike simple endocarditis the acute bacterial type shows no tendency towards fibrosis or healing. It is therefore primarily of pathological rather than clinical interest as the patients rarely survive for more than a few weeks. The clinical picture is that of a pyæmia and the endocarditis is usually a complication of osteomyelitis pneumonia multiple abscesses or suppurative arthritis. Fortunately the condition is relatively uncommon.

SUBACUTE BACTERIAL ENDOCARDITIS

This type of endocarditis is practically confined to patients with a pre-existing valvular lesion, which may be sometimes congenital or more commonly rheumatic. Even such a slight abnormality as a bicuspid aortic valve or a supernumerary cusp may predispose to subsequent infection. The clinical features and course of the disease are extremely variable. In its most frequent and usual form the illness starts as a general malaise with slight fever, which is often thought to be influenza. The temperature fails to subside, but examination may reveal nothing beyond a valvular lesion known to have been present for many years. The complexion is sallow, and there is an anaemia of microcytic type with a moderate leucocytosis. Night sweats are frequent and there is often a slight loss of weight. Petechial hæmorrhages may usually be seen at some stage of the disease occurring spontaneously in the skin and mucous membranes. A blood culture at this stage may produce a growth of *Streptococcus viridans*, or the cultivation may be negative at the first attempt, though ultimately positive cultures can nearly always be obtained. After a variable period, symptoms of embolism occur. In some cases there is pain in the extremity of a finger or toe accompanied by redness and swelling, indicating the blocking of an arteriole by an embolus, similar indurated and tender areas occurring in the skin are known as Osler's nodes. The spleen becomes palpable, and there may be abdominal pain due to perisplenitis over a splenic infarct. Albuminuria or hæmaturia indicate either embolic nephritis or infarction of the kidneys. A somewhat rare occurrence is embolism of the central artery of the retina which produces sudden and complete blindness in the affected eye. Examination shows pallor of the fundus with a bright cherry red spot at the macula. Embolism of mesenteric vessels may produce acute abdominal symptoms. The pyrexia continues, though occasionally for a few days it may be absent, usually without obvious improvement in the general condition. The fingers sometimes become clubbed. The heart may show but little change until the disease has lasted many months, but ultimately there is some enlargement, and perhaps a change in the character of the murmurs, or evidence of the involvement of a valve previously thought to be unaffected. After a variable period, usually not less than six or more than twelve months, death occurs, sometimes from heart failure and exhaustion, sometimes as the result of uræmia due to an acute focal nephritis, or sometimes from cerebral embolism.

Less typical forms of the disease than that described above may lead to great difficulty in diagnosis. In some cases the onset is relatively acute and the clinical features of the case may suggest typhoid fever, in others the disease may be almost latent with but slight and occasional pyrexia. Even in some seemingly mild cases, blood culture often reveal the presence of the *Streptococcus viridans*. This organism is of low virulence and in spite of the fact that infected emboli are being discharged into the arterial circulation in large numbers, suppuration does not occur.

The signs and symptoms of subacute bacterial endocarditis are dependent on two main factors the septicæmia and the embolic phenomena. The character of the disease depends in part upon the virulence of the infection and the extent and localisation of the infarcted areas. Among the symptoms resulting from the septicæmia are pallor and anæmia, pyrexia and splenic enlargement while the embolic side of the disease gives rise to a number of focal lesions both in the skin and viscera. Libman lays great stress on the importance in diagnosis of petechiæ in the skin and conjunctivæ tenderness on percussion over the lower end of the sternum and a brownish pigmentation of the face which is common in the later stages of the disease. He has also shown that in a certain proportion of cases bacteria disappear from the blood. Such a condition he terms the bacteria free stage. Unfortunately however the transition to this stage does not mean that the patient necessarily recovers as the damage wrought by emboli remains and frequently results in death from uræmia due to focal glomerular nephritis. Attempts at healing often produce still further aggravation of the old valvular lesions with resulting myocardial failure. Very occasionally the acute condition may subside and the patient regains apparent health though relapse is liable to occur. It is remarkable how rarely auricular fibrillation occurs in the course of infective endocarditis.

In subacute bacterial endocarditis the vegetations are most often confined to the mitral and aortic valves and destruction of the valve by ulceration is a less prominent feature than in acute infective endocarditis. The vegetations are relatively firm and often greenish in colour, they involve not only the valve cusps but also the mural endocardium and the chordæ tendinæ which may rupture.

The pathological changes found in other organs will vary with the extent and size of the infarcts produced. The spleen is large and may show infarcts and perisplenitis. The liver

may be nutmeg in type from a terminal cardiac failure. The kidneys are the site of small multiple emboli producing on the surface beneath the capsula minuta hæmorrhagic points which have given rise to the name flea bitten kidney. On microscopical examination there is a focal glomerular nephritis. In the brain there may be areas of softening due to emboli.

Differential Diagnosis — Differentiation from continued fevers such as typhoid, obscure forms of tuberculosis and suppuration is not always easy but a diagnosis of subacute bacterial endocarditis is strongly suggested by intermittent hæmaturia, petechial hæmorrhages, variable valvular murmurs, splenic enlargement and progressive anæmia. Blood cultures should be frequently repeated. A single negative culture does not exclude the disease and ultimately a positive culture is almost always obtained if the patient is really suffering from endocarditis of this type.

Treatment — No form of treatment appears to have any beneficial effect and as a rule the patient steadily deteriorates whatever is done. Anti-streptococcal serum and vaccines are useless and the intravenous administration of antiseptics such as eusol or mercurochrome seldom have any effect beyond adding to the patient's discomfort. Treatment with heparin is of no value. The only hope of recovery appears to lie in the patient's own resistance to the infection and plenty of open air and sunshine probably do more to help him than any drugs. If the anæmia is severe some benefit may be derived from blood transfusions.

CHRONIC VALVULAR DISEASE

It has already been pointed out that rheumatic endocarditis in a majority of cases leads to chronic valvular deformity. Although acute rheumatism and chorea are by far the most common causes of chronic valvular disease the condition may perhaps also result from scarlet fever. Syphilis is an important cause of aortic disease appearing in middle life but this results from degenerative changes in the aorta spreading to the valve rather than from a syphilitic process arising primarily in the valve itself.

Before passing to a consideration of the effects produced by lesions of the various valves it is necessary to lay stress upon the fact that valvular lesions in themselves do not produce any very prominent symptoms. The development of symptoms

in valvular disease indicates that the myocardium is unable to carry on its work efficiently. Such insufficiency results in part from the fact that in the presence of valvular disease the heart is working at a mechanical disadvantage but in the main it is due to slowly progressive changes in a myocardium previously damaged at the time of the original infection. In other words cardiac failure in valvular disease is ultimately due to a defective myocardium rather than to valvular damage. Conversely if the cardiac muscle remains efficient even severe and multiple valvular lesions may be compatible with normal health.

If syphilitic aortic disease be excluded the mitral valve is affected in chronic heart disease far more frequently than any other. Indeed in rheumatic heart disease it is doubtful whether the mitral ever escapes completely though obviously there may be considerable variation in the degree to which it is affected. In a series of ninety seven autopsies in cases of rheumatic fever collected by Carey Coombs the mitral valve was diseased in every case the aortic in fifty-seven and the tricuspid in thirty five. Minor degrees of mitral disease may however give rise to no definite physical signs and in practice it is relatively common to detect aortic disease without obvious mitral involvement in patients whose valvular disease is undoubtedly rheumatic in origin. Disease of the pulmonary valve is rare except in congenital heart disease. The tricuspid valve alone is never the seat of a chronic endocarditis but tricuspid disease is fairly frequently associated with rheumatic lesions of the mitral and aortic valves.

It has been already pointed out that if the myocardium is sound no symptoms result from a valvular lesion and often the subjects of chronic valvular disease live out their normal span of life until cut off by some intercurrent disease unconnected with the heart. Unfortunately, however this is the exception rather than the rule and most patients with a chronic valvular lesion ultimately show signs of cardiac failure which may follow one or more of three main types congestive cardiac failure infective endocarditis and the anginal syndrome the first being by far the most common.

MITRAL DISEASE

The mitral valve is affected by chronic valvular disease far more frequently than any other valve. Although mitral disease is usually described under the headings of regurgitation and stenosis it is very doubtful whether these two processes are not always concurrent but in the more severe and chronic

cases, stenosis is the predominating clinical feature. The diagnosis of pure mitral regurgitation as distinct from stenosis is always a matter of doubt, owing to the frequency of systolic murmurs at the apex, apart from mitral disease.

Mitral disease is so commonly due to rheumatic fever or chorea that the number of persons suffering from mitral disease is an index of the amount of acute rheumatic infection in any given community. Fully developed mitral stenosis is unusual before puberty and on the whole females are more frequently affected than males. The majority of patients are between the ages of fifteen and forty five and many fail to survive the latter age.

Morbid Anatomy of Mitral Disease—Most of the cases which come to autopsy as the result of mitral disease show a stenosis of the valve accompanied by more or less incompetence. On naked eye inspection the heart in an advanced case of stenosis has a most striking appearance owing to the relatively small size of the left ventricle as compared with the great dilatation of the left auricle and of the right side of the heart. The dilatation and hypertrophy of the right ventricle and left auricle might reasonably be expected, as the narrowing of the mitral valve offers obstruction to the flow of blood from the right side of the heart to the left. The left auricle is often enormously dilated and, although hypertrophy of the muscular wall is not obvious at first sight comparison of the thickness of the wall with that of a normal auricle shows there is considerable hypertrophy. The dilatation of the right side of the heart is very obvious and in consequence, even in the absence of tricuspid disease, this valve is widened and incompetent. Thrombi may be present in the auricles (atria), more particularly in the auricular appendices (auricles) these are usually adherent to the walls but occasionally a large circular thrombus may be free in the auricle and act as a ball valve.

The cusps of the mitral ring are thickened and often partially fused as the result of a chronic fibroid infiltration, sometimes there is actual calcification, the chordæ tendinæ are shortened thickened and partially fused. Viewed from the auricular side, the mitral valve often shows a funnel shaped orifice which will not admit the tip of a finger, sometimes the valve resembles a diaphragm separating the ventricle from the auricle and the opening is reduced to a mere button hole slit. Recurrences of acute endocarditis often occur on valves already scarred by chronic endocarditis, and in such a case, in addition to the valvular deformities described above,

there may be lines of recent vegetations. From an inspection of mitral valves affected by stenosis it is often obvious that complete closure of the valve is an impossibility. In such cases although stenosis must have been accompanied by regurgitation yet frequently no systolic murmur was present during life.

Physical Signs of Mitral Disease—The fallacy of assuming that every apical systolic murmur represents an organic mitral incompetence has already been stressed. Mitral incompetence apart from stenosis should be diagnosed only in cases with cardiac enlargement, a history of rheumatism or chorea and a harsh blowing systolic murmur best audible at the apex and propagated towards the axilla, such a murmur being often accompanied by a systolic thrill. It may also occur in elderly patients with enlarged hearts and atheromatous changes.

In uncomplicated mitral stenosis there may be little or no enlargement of the heart to the left as judged by the position of the apex beat or the cardiac dullness. The latter is however usually increased to the right of the sternum particularly if there is congestive failure. On palpation a diastolic thrill may often be felt over the apex and on auscultation in such cases there is a diastolic murmur often termed *presystolic*¹ crescendo in character which leads up to a markedly accentuated and abrupt first sound. This diastolic murmur is localised and most commonly situated slightly internal to the apex beat. A systolic murmur may be present in addition is wider in its distribution and best heard over the apex and towards the axilla. The murmur of mitral stenosis is usually more obvious if the patient is exercised and then auscultated while lying on the left side.

Often in mitral stenosis no presystolic thrill or murmur is present but during diastole there is a long rumbling diastolic murmur best heard at the apex but without the crescendo character of the presystolic bruit. Such a murmur often termed *mid diastolic* is commonly heard in patients with mitral stenosis when there is auricular fibrillation.

In mitral stenosis whether there is a presystolic or a more prolonged diastolic murmur the second sound at the pulmonary area is accentuated or sometimes reduplicated presumably owing to an increased pressure in the pulmonary artery.

¹ The terms *presystolic* and *late diastolic* refer to the fraction of diastole that immediately precedes the commencement of the first sound, i.e. the *beginning* of ventricular systole and are more or less synonymous. The term *auriculo systolic* is also sometimes used in a similar sense in that auricular systole normally occurs immediately before the commencement of the first sound.

The murmurs in mitral stenosis are somewhat inconstant and may vary in character with change of posture or rate of heart beat. In every case however, the murmur remains diastolic in time whether best heard late in diastole (presystolic) or more accentuated during mid diastole. With rapid heart action the murmur extends through the whole of diastole. When auricular fibrillation supervenes the murmur loses its presystolic accentuation. Diastolic murmurs due to mitral stenosis are frequently though not invariably accompanied by a thrill which is best felt over the apex impulse with the patient on his left side. It is important to remember that simple accentuation of the first sound at the apex does not indicate mitral stenosis as it may occur in any heart which is beating rapidly and forcibly.

Symptoms of Mitral Stenosis—No specific symptoms are associated with mitral stenosis unless the heart muscle is failing. Should this occur the clinical picture described under the heading of congestive cardiac failure (*vide* p. 549) will be present. Although patients even with a considerable degree of stenosis may live for many years with but little impairment of activity, they are usually considerably under developed and even in the absence of failure may show a characteristic malar flush. In congestive failure due to mitral stenosis hæmoptysis is common. Most often it is due to a pulmonary infarct or to pulmonary congestion and failure but it may also sometimes occur without evidence of failure.

Prognosis—The ultimate outlook is always bad in cases of developed mitral stenosis as the fibroid change in the valve usually progresses steadily even if slowly. If the patient succeeds in surviving to middle life the degenerative changes in the heart muscle and arteries which tend to occur after the age of fifty throw an increased burden on an already damaged heart and cardiac breakdown is likely to result. More often the cardiac muscle begins to feel the strain at a far earlier age and in a majority of patients the onset of *auricular fibrillation leads to a condition of complete or semi-invaldism*. Even so with adequate care and treatment life may be maintained for many years.

AORTIC VALVULAR DISEASE

Whereas chronic disease of the mitral valve is predominantly rheumatic in origin this is not true of aortic valvular disease in which syphilis is almost as important a factor as acute rheumatism. In addition in later life disease of the aorta and

its valve may result from arteriosclerotic and degenerative changes alone. As a general rule it may be said that aortic disease, unaccompanied by a mitral lesion and occurring between the ages of forty and sixty, is predominantly syphilitic. Rheumatic disease of the aortic valves, on the other hand, is common in early life, and, in a majority of cases is complicated with mitral disease. Aortic syphilis is dealt with elsewhere (*vide p. 575*). Very rarely rupture of an aortic cusp takes place as the result of a blow on the chest or a sudden strain. When this occurs the patient may be conscious of something in his chest having given way, and the signs of aortic regurgitation are found to be present.

Morbid Anatomy.—The cusps of the aortic valve are thickened and less flexible than normal, fusion between adjacent cusps may occur, and nodular vegetations which may be hard and even calcified, prevent satisfactory closure of the valve. Sometimes the thickening and rigidity lead to narrowing of the lumen. As a result of the leakage of blood through the aortic valve, additional work is thrown upon the left ventricle, which becomes dilated and hypertrophied.

Physical Signs of Aortic Valvular Disease—Lesions of the aortic valve may result either in regurgitation or stenosis or both. The physical signs will depend upon the type of defect present.

Aortic Regurgitation—The physical signs are usually quite definite. The apex beat is unduly forcible and usually well outside the mid clavicular line. Over the base of the heart and often down both sides of the sternum there is an early diastolic murmur blowing in character, which often replaces the second sound. The bruit may be very faint and heard only when the chest is examined in a quiet room. Although an aortic regurgitant murmur is usually best heard over the aortic area sometimes it may only be audible lower down the right or left border of the sternum. In addition there is often a systolic murmur over the base when it is described as a to and fro murmur.

In addition to the early diastolic murmur described above in some cases there is also a presystolic or rumbling mid diastolic murmur at the apex, which resembles the murmur of mitral stenosis. This is termed an Austin Flint murmur. Its origin is doubtful, but it may be due to a relative stenosis of the mitral valve in comparison with the dilatation of the left ventricle, which has taken place owing to the aortic lesion. There is often considerable difficulty in deciding whether such a murmur is a Flint murmur or an indication of concomitant mitral stenosis. A history of rheumatic fever and the age of

the patient are important. If the aortic disease is syphilitic in origin, the mitral valve is unlikely to be involved, whereas with a rheumatic aortic lesion the mitral valve is almost invariably the site of concurrent endocarditis.

Apart from the examination of the heart, other signs may point to aortic regurgitation. The most important of these is a quickly rising and rapidly collapsing character in the pulse, which is known as the *Corrigan* or "water hammer" pulse. Visible capillary pulsation occurs and may be demonstrated most readily by pressing a glass slide upon the mucous membrane of the lip, when alternate flushing and pallor are observed corresponding to each systole and diastole. When aortic regurgitation is severe marked arterial pulsation is visible in the neck and in all subcutaneous arteries. The systolic pressure is high and the diastolic low with a resultant high pulse pressure. A record of the pulse pressure is very useful for watching if any increase of the incompetence develops. When the incompetence is only slight so that very little blood regurgitates back into the ventricle there may be little or no fall in the diastolic pressure, although a diastolic murmur is audible.

Aortic Stenosis—When the aortic valve obstructs the outflow of blood from the ventricle, the latter hypertrophies, partly in an attempt to overcome the obstruction and partly as a result of myocardial involvement. A systolic thrill is felt over the aortic area and there is a very loud harsh murmur, blowing in character, best heard over the base and propagated upwards towards the neck. Usually an early diastolic bruit indicates coincident regurgitation. With advanced aortic stenosis the heart rate may be slow and the pulse slowly rising in character. Aortic stenosis is relatively infrequent, and should never be diagnosed in the absence of a thrill. In rheumatic cases the heart is usually much enlarged.

Symptoms—Aortic disease of rheumatic origin is latent as regards symptoms more often than any other organic heart lesion. It is not at all uncommon to find patients who have had well marked aortic disease for many years with no impairment of health or activity. In the syphilitic cases however, there is nearly always evidence of associated myocardial involvement usually accompanied by pain (*vide* p. 577). In aortic disease of rheumatic origin, failure of the congestive type may eventually supervene though this is less common than in mitral stenosis. When failure occurs in aortic disease, attacks of vertigo and sudden syncope are common and pain in the chest is more frequent than in mitral disease. Troublesome throbbing in the neck, and headache also occur,

which may interfere with sleep. In the later stages of failure due to aortic regurgitation, mental symptoms such as delusions and hallucinations are often present.

The bad prognosis which, until recent years, was usually given in aortic regurgitation, was the result of a failure to differentiate between the aortic lesions due to rheumatism and those occurring as sequelæ of syphilis and arteriosclerosis. In the rheumatic type the outlook is relatively good but syphilitic and arteriosclerotic disease, involving the aortic valves, implies more widespread lesions in the cardio vascular system and the patient, even with treatment, usually goes steadily downhill. Sudden death is not uncommon.

CHRONIC VALVULAR DISEASE OF TRICUSPID AND PULMONARY VALVES

Except in congenital heart disease and infective endocarditis the pulmonary valve is rarely affected. In severe mitral stenosis with right sided dilatation, there may be regurgitation through the pulmonary valve as a result of stretching of the valve ring. In such cases an early diastolic murmur, known as a Graham Steell murmur, is heard along the left border of the sternum and is indistinguishable from that of aortic disease. The diagnosis rests upon the site of the murmur and the absence of other evidence of aortic regurgitation but in actual practice it is often found that a murmur, thought to be pulmonary in origin eventually turns out to be aortic. Pulmonary stenosis is discussed in its relation to congenital heart disease (*vide* p. 564).

Although less liable to chronic endocarditis than the mitral or aortic the tricuspid valve is by no means immune. It is, however, excessively rare to find the tricuspid involved apart from disease on the left side of the heart. Incompetence is common in the later stages of congestive failure but stenosis is relatively rare. The latter is evidenced by a diastolic bruit heard near the lower end of the sternum but care must be taken not to confuse it with a mitral murmur. A pulsating liver is a valuable sign of tricuspid disease.

CHRONIC DISEASE OF THE HEART MUSCLE (Myocardial Degeneration)

Death very commonly occurs as the result of progressive circulatory failure. In the majority of such cases autopsy reveals well marked evidence of disease, in an appreciable

percentage, however, there is no naked-eye or histological evidence of abnormality. This is frequently the case in patients dying of tuberculosis, Graves's disease, or cachexia of varying origin. A diagnosis of myocardial degeneration, a term implying visible histological alteration, can thus only be arrived at with certainty after death. At the bedside, therefore, it is better to speak of myocardial insufficiency rather than of myocardial degeneration.

Ætiology.—The following factors are so frequently part of the clinical picture of chronic myocardial degeneration that they may safely be regarded as predisposing causes:—

1. Arteriosclerosis and senile changes in the blood vessels, with or without a high blood pressure.
2. Chronic nephritis.
3. Chronic pulmonary disease, *e.g.*, emphysema, bronchiectasis, chronic bronchitis.
4. Any rheumatic disease of the heart.
5. Hypo- and hyper-thyroidism.
6. Certain poisons, *e.g.*, phosphorus, chloroform, lead.
7. Hypovitaminosis, especially of the vitamin B group.

Morbid Anatomy.—Myocardial damage may take one of the following forms:—

(a) *Cloudy Swelling.*—This is characterised by unusual softness and pallor of the ventricular muscle, which may be pinkish in colour and is friable to the touch. Microscopically the fibres are swollen and granular. Cloudy swelling is common after prolonged pyrexia from any cause. Complete recovery takes place.

(b) *Fatty Infiltration.*—By this is meant a pathological increase in the fat normally present in the epicardium, with an extension or ingrowth of it into the underlying muscle, which may even be replaced by fat. In an extreme case fat appears beneath the endocardium in streaky yellow patches extending to the columnæ carneæ (trabeculæ carneæ). Many muscle fibres atrophy and disappear, the survivors forming thin strands separating columns of fat. Fatty infiltration occurs commonly, though not invariably, in obese persons.

(c) *Fatty Degeneration.*—By this is meant the occurrence of fatty globules within the muscle fibres. It occurs particularly in association with any severe anæmia, such as pernicious anæmia, and the leukæmias. It is conspicuous in phosphorus and chloroform poisoning. In chronic lung conditions the right ventricle may be chiefly affected, otherwise the left usually shows the fatty change most markedly. In the anæmias, the

distribution of fatty changes is patchy, giving rise to a characteristic "thrush breast" appearance or "tabby cat" striation in the papillary muscles. Fatty changes usually follow in the wake of disease of the coronary arteries.

(d) *Brown Atrophy*—In chronic wasting diseases, such as carcinoma or tuberculosis, the heart is often rather smaller than normal, and of a brownish tint on section. It may weigh only half the normal. The muscle is not only brown but friable, and the coronary vessels are tortuous. Microscopically the fibres are smaller than usual, and contain a greenish pigment which does not give the so called "iron reaction". This distinguishes brown atrophy from the increased pigmentation present in haemochromatosis.

(e) *Fibrosis of the Myocardium*—By this is meant an overgrowth of connective tissue in the heart walls. It may occur in localised patches or diffusely throughout the organ, it may be obvious to the naked eye or require special methods for detection. Fibrosis is invariably a sequel to previous damage brought about in various ways: (1) occlusion or narrowing of the coronary arteries and their branches, (2) acute inflammation of the endo- or pericardium extending into the heart muscle, (3) syphilitic disease, (4) tuberculous infection (very rarely). Narrowing or complete occlusion of the coronary vessels may occur near the origin of the main arteries at the aorta, or distally and diffusely in the smaller ramifications. In the former event a large area of muscle will be infarcted and gradually replaced by fibrous tissue if life continue. With occlusion of numerous small branches there will be multiple regions of fibrosis. The clinical picture depends on the rate of onset of complete and continued occlusion, and on the size of the vessel concerned (*vide p. 546*). In embolism the cessation of blood supply is practically instantaneous, in thrombosis resulting from arteriosclerotic changes and long continued narrowing, it is more gradual. In the latter circumstances some slight anastomosis develops with branches of vessels not involved, and the final closure is not attended by such marked or serious consequences as occur in sudden embolism. Arteriosclerotic changes in the left coronary artery and its branches lead to fibrosis of the left ventricle, at its apex particularly. The muscle wall becomes thin, pale, and stiffened. Thrombotic material is liable to collect in the ventricular cavities over the region affected. The fibrosis and thinning of the heart wall occasionally leads to sudden rupture or aneurysm formation. Rupture is particularly liable to occur after complete occlusion before the soft infarct has had time to be replaced by fibrous

tissue In inflammatory disease of the endocardium or pericardium, the myocardium is always invaded as well. Along with sclerosis of the valves and fibrous changes in the pericardium, connective tissue increases in the heart muscle itself. When the septum is involved, interference with the bundle of His may lead to heart block. Syphilis of the myocardium occurs in the form of a few large gummata or many small ones diffusely scattered, the septæ are frequently involved, and heart block is common. In congenital syphilis the myocardium may be filled with spirochaetes and yet no fibrosis be found. On the other hand, there may be a general diffuse increase in connective tissue, as in the liver, lungs, and other organs. It is remarkable how immune the heart muscle appears to be in miliary tuberculosis, though tuberculosis of the myocardium has been described.

Symptomatology—The clinical manifestations of chronic myocardial degeneration all result from insufficiency of the cardiac muscle. They vary widely in different individuals, but may be described under three main headings —

Cardiac Enlargement—This is nearly always present, but to detect the enlargement special X ray methods may be necessary. The brown atrophy of senile hearts is the outstanding exception, and angina pectoris often occurs with little or no enlargement of the heart.

Circulatory Failure—In the early stages a persistently low exercise tolerance may be the only evidence of disease. Slight exertion such as hurrying on the level or walking up an incline, produces undue respiratory distress or even precordial pain. Later, in the absence of some sudden terminal event, congestive cardiac failure supervenes.

Special Symptoms and Signs—Any of the arrhythmias, and particularly extra systoles, may occur. Heart block may be found. Although sensory symptoms are by no means invariable, pain beneath the sternum or less significantly over the apex, in the epigastrium or radiating down the inner aspect of one or other arm is extremely common (*vide* p. 543). Dyspepsia and flatulence, headache, attacks of faintness or dizziness, are frequent. The memory often fails, and all grades of mental disorder may be observed. The character of the heart sounds will depend on the condition of the ventricular muscle. In the absence of valvular disease it is not uncommon to find the first and second sounds altered in quality, but there is no characteristic change. Frequently the sounds are feeble and rapid, the so called "tic tac" rhythm. Occasionally reduplication of the first and second sound produces the

so called 'gallop' rhythm, this always indicates a grave prognosis and is often found with cardio renal disease

The Heart in Myxœdema—In myxœdema and cretinism the capacity of the heart to perform work is often diminished. The important characteristics of the myxœdema heart are enlargement, a sluggish cardiac action, and electrocardiographic changes. The enlargement of the heart involves all chambers and may be of great degree. The most noteworthy feature of the enlargement is that it diminishes when thyroid extract is administered. The cause of the enlargement is not at present clear but is probably due to dilatation as a specific result of thyroid deficiency, in that in the absence of thyroid hormone the capacity for work of the heart is diminished. In some cases an associated anemia is a contributory factor.

The sluggish cardiac action is revealed by a slow circulation time, small cardiac contractions as shown by fluoroscopic examination and the presence of distant heart sounds. The chief electrocardiographic changes are a diminished voltage of the P and QRS waves in all leads. The T waves may be low, flat or inverted. The waves return to normal amplitude as a result of thyroid treatment.

It is noteworthy that congestive cardiac failure only occurs in a small percentage of cases with myxœdema heart. This is apparently due to the fact that as the energy requirements of the body in hypothyroid states are so diminished the sluggish enlarged heart can deal with them adequately. Indeed, when congestive cardiac failure in myxœdematous patients does occur, there is not infrequently an associated arteriosclerosis. In those rare instances where the failure is essentially a myxœdematous one the condition is benefited by thyroid treatment.

Deficiency of Vitamin B₁—In diseases due to deficiency of certain members of the vitamin B group such as occurs in beriberi pathological changes can be observed in the heart. This deficiency may occur in heavy beer drinkers. Histologically there occurs hydropic degeneration of the myocardial fibres with a perivascular œdematous reaction. These changes however are not of regular occurrence and may be found in conditions other than beriberi. Clinically there is enlargement of the heart involving particularly the right side and cardiac failure with congestion frequently follows.

At autopsy hypertrophy and dilatation of all the chambers are found. Adequate treatment with vitamin B₁ produces beneficial results with a diminution in the size of the heart. Digitalis therapy has no such effect.

Clinically this type of myocardial degeneration is usually associated with peripheral neuritis but in some cases there is only a history of dietary insufficiency of vitamin B containing foods

Cases of pellagra frequently show symptoms and signs of cardio vascular damage and it is probable that this is due to the association of a vitamin B₁ deficiency in this disease

In human scurvy changes in the myocardium have been described. It is not clear that vitamin C deficiency is responsible for there is usually present a multiple vitamin deficiency and the cardiac lesions may be due to the lack of vitamin B₁. Vitamin C is low in rheumatic fever but its administration has no effect on the clinical course of the condition and does not reduce the incidence of recurrences

THE ANGINAL SYNDROME

The term angina as applied to cardiovascular symptoms indicates paroxysmal discomfort or pain referred to the substernum or precordium. It is important to realise that angina pectoris is a symptom complex rather than a disease and that it may occur in a number of pathological conditions not necessarily closely related to one another either as regards the site or type of the pathological lesion. For example anginal symptoms may occur with coronary sclerosis with syphilis of the aorta occasionally with rheumatic disease of the aortic valves with myocardial disease of unknown origin or with severe anaemia whatever its cause

Angina may be regarded as a type of cardiac failure which is specially prone to occur with the chronic and degenerative changes which involve the heart and aorta after middle life. It is of interest to note that anginal pain is uncommon in congestive cardiac failure. If this type of failure becomes established in a patient who has previously been subject to angina the attacks usually cease although cardiac insufficiency may be both considerable and progressive

Just as angina is the result of varying pathological conditions so also it varies very widely in its severity and clinical features. At one end of the scale it may be little more than a sense of oppression beneath the sternum which rapidly disappears with rest at the other it may be a pain of such intensity and torment that the patient may die in an attack. Between these two extremes there is an almost infinite gradation of symptoms the only common factor in which is

pain or discomfort referred to the region of the precordium and to the sternum in particular

Morbid Anatomy.—Although the anginal syndrome may occur in a number of pathological conditions affecting the heart or aorta, at autopsy there is always found some degree of coronary sclerosis or some obstruction to the mouth of a coronary artery that produces some ischaemia of the myocardium. As a result of this, there is also evidence, naked eye or microscopical, of fibroid changes in the heart muscle. In some cases death may have occurred as the result of a coronary occlusion with resulting infarction of the heart muscle. In addition to the coronary sclerosis there are usually generalised arteriosclerotic changes in other vessels. Sometimes the coronary vessels themselves may be reasonably patent, but the presence of arteriosclerotic plaques near their origin in the aorta may have obstructed the blood flow. In other cases of angina syphilitic aortitis is found (*vide* p. 576). In the majority of cases the heart is found to be enlarged.

Ætiology.—Angina pectoris, especially in its more severe forms, is far more common among males than females. It is primarily an affliction of the upper classes and is less often seen among manual workers. It is most prone to occur in those who have been subjected to heavy responsibility and mental strain, and it is specially common among medical men. Although overindulgence in food, drink, and tobacco may play a part, any factors which tend to produce arteriosclerosis are important. Of these, heredity has perhaps the greatest influence. Angina, like gout, arteriosclerosis, and cerebral hæmorrhage, often tends to recur in successive generations of one family.

Angina is a common feature of syphilitic aortitis, and here it may occur even below the age of forty, whereas angina due to other causes is increasingly common from forty upwards. Very occasionally angina may occur in patients with rheumatic aortic disease. Rheumatic mitral lesions, however, are seldom if ever associated with conspicuous pain, though aching under the left breast is not uncommon when the patient is tired or overworked.

The mechanism of the symptom appears to depend upon a relative or absolute anoxæmia of the myocardium. Thus angina pectoris is found not only in the presence of coronary narrowing but may sometimes occur in the course of profound anæmia or during an attack of paroxysmal tachycardia.

Symptoms of Angina Pectoris.—In its less severe forms, angina is a feeling of oppression or discomfort behind the sternum or over the precordial area, and the onset of an attack

is as a rule definitely related to exercise. A patient subject to such attacks may be able to walk in comfort on the level and at a reasonable speed, but should he have to hurry, to walk uphill or against a strong wind, he develops sternal or precordial discomfort or pain, which grows steadily worse if he persists with the exertion; if, however, he stops to rest, the symptoms pass off completely in the course of a few minutes. Often the symptoms are more severe, there may be a definite gnawing pain over the precordium which may radiate upwards into the neck or down the arms, particularly the left arm. Nor are the attacks any longer brought on only by exertion. In the more fully developed cases of angina the paroxysms may start as the result of emotion, anger, or excitement, or they may be precipitated by slight external stimuli such as cold, or by an unusually heavy meal. Sometimes, indeed, the unfortunate sufferer may have severe attacks without any obvious cause, even when at rest in bed.

In the extreme grades of the malady the patient presents a striking clinical picture. The attack begins abruptly with excruciating pain in the region of the heart. It may be confined to the sternum or may radiate thence down the inner aspect of the left arm, sometimes down both arms, up into the neck, or down towards the epigastrium. The chest feels as though it were gripped in a vice, and there may sometimes be a senso of impending death which occasionally is justified by the result. These subjective sensations are associated with an ashen pallor of the face, holding of the breath, and a complete immobility. The sufferer is obviously afraid to move or even to breathe. The agony of even a severe attack seldom lasts more than a couple of minutes and its duration is often a matter of seconds only, though to the patient himself it may seem an eternity. He may break into a profuse perspiration, and for some time after the attack may be strikingly dyspnoeic and complain of intense fatigue. If an examination can be made during an attack—a rare event—the pulse is found to be soft and regular and is seldom increased in rate. The blood pressure, however, has been shown to rise before the onset and during a paroxysm. Often after the subsidence of an attack there may be hyperæsthesia over the precordium and sometimes moist sounds at the bases of the lungs.

Diagnosis—The diagnosis of angina pectoris is often one of considerable difficulty, particularly when, as often happens, the patient is not seen in an attack. In such a case the history of the patient is of the greatest importance. The important factors are —

1 The age angina pectoris is very rare before about forty years of age

2 Diminished exercise tolerance the great majority of sufferers from angina are unduly dyspnoic on slight exertion

3 Evidence of a cardio vascular lesion most patients who suffer from angina will show objective evidence of disease such as cardiac enlargement or aortic valvular disease Thickening of the radial or retinal arteries may be the only clinical evidence of arteriosclerotic changes but X ray examination may show that the aorta is dilated or that a doubtful heart is really enlarged It is important to realise that a normal electrocardiogram in no way precludes the occurrence of angina though electrocardiographic changes are the most valuable sign

Perhaps the most significant point in the diagnosis of angina is that in this condition the attacks of pain are induced by exertion and relieved by rest Any substernal or precordial pain in a patient of middle age or over which has these characteristics must be viewed with grave suspicion In the more severe types where the pain comes on spontaneously there is likely to be confirmatory evidence in the form of objective evidence of cardio vascular disease and the attacks are also likely to be sufficiently typical to justify the diagnosis The differentiation between an anginal attack and coronary occlusion is dealt with below (*vide p. 49*)

Sub-mammary Pain—Pain in the precordium and particularly in the sub mammary region is not uncommon in patients in whom there is no demonstrable cardio vascular lesion Such pain was in the past often described as pseudo angina a term which is misleading to the medical man and often disastrous for the morale of the patient It is common among the emotionally unstable and particularly among women at the menopause The pain is usually beneath the left breast rather than substernal and is often described as aching or gnawing in character it is more prolonged than an attack of angina and is often alleged by the patient to be present continuously for long periods It is not noticeably increased during exertion though it may be aggravated after exertion or by emotion or excitement Often there is striking hyperesthesia in addition Unlike angina such pain is not characterised by immobility and holding of the breath but rather by restlessness and agitation Often there are in addition other evidences of vasomotor or nervous instability, such as cold extremities attacks of migraine neuralgia or flushes of heat Sometimes precordial pain or discomfort is associated with the immoderate use of tobacco, tea or coffee

Pain in the left side of the chest is not uncommonly associated with dyspepsia, particularly when there is much gastric distension. The patient often complains of "wind round the heart," and when eructation occurs the discomfort is promptly relieved. Distension of the stomach with air is a frequent occurrence in the reflex dyspepsias resulting from cholecystitis, but it often results simply from aerophagy in nervous dyspepsia. Correction of the diet, or such drugs as helladonna or alkalis, may relieve the symptoms and thus aid in the diagnosis from angina pectoris. It must be remembered, however, that attacks of angina pectoris may be induced by a heavy meal and may be followed by eructation. Amyl nitrite, though usually effective in the relief of anginal pain, has no effect.

Vasovagal Attacks—These attacks, originally described by Gowers, may sometimes be confused with angina. Though the patient may complain of a sense of constriction in the chest there is no severe pain and the most striking symptom is a sense of impending death. Vasovagal attacks most frequently occur in women who are debilitated and have been subject to prolonged emotional stress. Though the sensation that death is imminent is very vivid and alarming, death does not occur in an attack and there is rarely any objective evidence of heart disease. With reassurance and rest there is usually a gradual improvement though the attacks may recur for years. Unlike anginal attacks they are not brought on by exercise. They probably account for many of the cases vaguely diagnosed as pseudo angina. During a vasovagal attack the pulse may be extremely slow and sweating profuse.

Treatment—Since angina pectoris is an indication of cardio vascular disease, almost certainly progressive, and since there is always the possibility of sudden death in the next attack, it is important to recommend a regime which excludes as far as possible such factors as predispose to an attack. Sudden exposure to cold must be avoided, bed and bedroom should be warmed, as contact with cold sheets may precipitate an attack. Any exercise which may be regarded as excessive for the individual concerned, mental strain, and over indulgence in food, drink, and tobacco should be forbidden. Exertion shortly after a meal is to be avoided. In the presence of syphilis, a preliminary course of mercury and iodides must be given before administering arsenical compounds (*vide p 580*). Under a satisfactory regime patients often survive for many years. To the patient's friends, however, it is probably wise to be frank as to the possibility of a fatal attack at any time.

In an attack trinitrin tablets, $\frac{1}{16}$ or $\frac{1}{8}$ gr, chewed and placed under the tongue, or inhalation of amyl nitrite—a capsule containing M3 crushed in a handkerchief will suffice—will usually terminate the attack abruptly, though sometimes it may fail. Morphine and atropine in full doses may be necessary when severe attacks recur at brief intervals. Continued administration of sodium nitrite ($\frac{1}{2}$ to 2 gr) or of liquor trinitrin (M1 to 2) are not likely to be effective in diminishing the frequency of attacks, but bromides and other sedatives often are. Operative measures, such as thyroidectomy or sympathectomy, have on the whole proved ineffective.

CORONARY OCCLUSION

There is one important clinical syndrome associated with sudden acute substernal or epigastric pain that deserves a special description, namely, that caused by occlusion of a coronary vessel. In every case of angina pectoris where the pain continues for fifteen minutes or longer, occlusion of a coronary vessel must be suspected.

Morbid Anatomy.—The coronary arteries anastomose so poorly that the permanent occlusion of a coronary vessel always leads to the death of the muscle supplied by it. The size of the resulting infarct depends both on the suddenness of the closure and on the size of the vessel involved. When the main coronary vessels are occluded, sudden death, or death after a short interval, is the rule. Occlusion of fairly large branches is, however, compatible with life, provided it occurs gradually. Sudden occlusion even of a small branch may be immediately fatal. In the hearts of patients who have survived a number of agonising seizures, localised patches of fibrosis may be found, suggesting that some of the anginal attacks may have been due to the gradual occlusion of some small coronary branch. The region deprived of its blood supply undergoes the morbid changes associated with infarction. The presence of necrotic tissue in the heart wall gives rise to leucocytosis and pyrexia. If the infarct extends to the pericardium, a pericardial thrombus forms. If it extends to the endocardium, a mural thrombus develops, portions of which may break off to form emboli in the lungs, brain, spleen, kidneys, or elsewhere. If the patient survives, the infarct gradually becomes replaced by fibrous tissue with or without weakening of the heart wall. Occasionally an aneurysmal dilatation with subsequent rupture may occur at the site of a previous infarction.

Ætiology—The blocking of a coronary vessel is due to formation of a thrombus in its lumen. Hence all causes predisposing to atheroma or arteriosclerosis are of importance, such as prolonged high blood pressure, old age, chronic nephritis, gout, syphilis, heredity, tobacco, mental worry, over indulgence in food and drink.

Symptoms—Coronary thrombosis occurs more often when the patient is at rest than when he is active. The onset of symptoms is very sudden and the patient is at once seen to be gravely ill. The initial symptoms are pain and collapse. The pain is usually substernal but it may sometimes radiate into the epigastrium. The pulse is thin and rapid and the blood pressure often very low. The patient rapidly becomes pale or cyanosed. In spite of severe collapse the mind is usually clear. Sometimes death may occur within a few hours of the onset. The pain persists for hours or even for days, especially if it is not controlled by morphia. During the first twenty four hours the temperature is subnormal but later it rises and pyrexia may continue for a week or more. At the same time a polymorphonuclear leucocytosis develops. After the pain has passed off the patient's main complaint is one of extreme exhaustion.

On physical examination during the initial stage of shock the heart sounds may be barely audible, but râles are frequently heard at the bases of the lungs. After a few days a pericardial rub may be detected but this is often very transitory. Occasionally coronary thrombosis may be accompanied by the sudden development of an arrhythmia, such as auricular fibrillation or heart block.

If the patient survives for seven days or longer embolic phenomena may appear. The emboli are formed from detached intraventricular thrombus and they may lodge in the lungs, brain, spleen, kidneys, or elsewhere. The risk of embolism persists for about four weeks and patients who appear to have survived the initial dangers of coronary occlusion may succumb to a large embolus, most commonly in the lung. Sometimes life is terminated by a second coronary thrombosis within a few weeks.

Often when the patient survives the initial stage of collapse he may gradually develop symptoms of congestive cardiac failure with pulmonary œdema and anasarca. In such cases he often becomes confused and delirious and dies within a few weeks.

Coronary occlusion is frequent among the aged and in such cases there may often be little or no precordial pain and few characteristic symptoms.

The electrocardiographic findings are not constant, but may

be suggestive. The conspicuous alteration in the electrocardiogram is in the T wave which is inverted in leads I or III. The T wave in lead II may also be inverted in conjunction with an inverted T either in leads I or III. The T wave in lead III may be unusually elevated when in lead I it is inverted and *vice versa*. Often that portion of the curve immediately succeeding the R or S wave tends to become raised above or depressed below the base line (vide Fig 15)

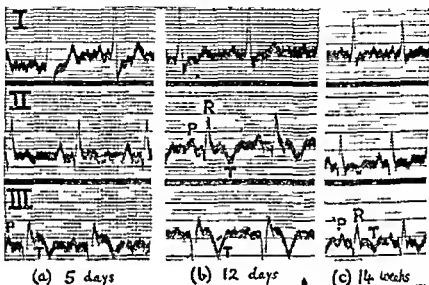


FIG 15—Electrocardiograms from a man aged 54 (a) 5 days (b) 12 days and (c) 14 weeks after a coronary thrombosis. In (a) in lead III, the portion of the curve during the ST interval is raised above the base line and T is slightly inverted. In (b) T is deeply inverted in leads II and III. In (c) these have returned some way towards the normal. After the thrombosis the temperature rose to 102 for 4 days, the white count rose to 9000 and the systolic blood pressure fell from 160 to 90 mm. of mercury.

(From an Electrocardiogram by Dr Maurice Campbell.)

Sometimes lead IV may show inversion of the T waves before they have developed or after they have disappeared in the other leads.

As is clear from the preceding description the condition may simulate closely such abdominal emergencies as perforation of a peptic ulcer, acute gall stone colic and acute hemorrhagic pancreatitis. The dyspnoea, pallor, fall in blood pressure and later a pericardial friction rub are perhaps the most reliable points of difference in the early stages. In perforation the presence of gas below the diaphragm in an X ray clinches the diagnosis.

A coronary thrombosis often produces symptoms which are regarded by the patient, and sometimes by his doctor, as due to "acute indigestion." It is surprising how often the word "agonising" is used of the pain by sensible patients and this should put the doctor on his guard against accepting the diagnosis of indigestion. Flatulence may be a very prominent symptom. Sudden onset of severe discomfort, distension or pain in the upper epigastrium, occurring in a patient over middle age must always be regarded with suspicion.

Coronary thrombosis is differentiated from an attack of angina pectoris (1) by absence of relation to effort, (2) the relatively long duration of the pain, (3) symptoms of shock.

Prognosis—Coronary occlusion is probably the commonest cause of sudden death. Many of its victims die within a few days but there is no malady in which it is so difficult to give a definite prognosis. The most desperately ill patients not infrequently confound all prophecies by recovering while others who appear to be doing well may develop cardiac failure or rupture of the heart or may die of an embolism. In general it may be said that the younger the patient the better the prognosis as regards complete recovery, but even patients over seventy may recover and live for many years.

Treatment—The most immediate need is to relieve the pain by adequate injections of morphia ($\frac{1}{4}$ to $\frac{1}{2}$ gr.) repeated if necessary. The nitrites are not only useless but dangerous as they produce a further fall in blood pressure. Absolute rest with expert nursing is essential. Under no circumstances should the patient be moved after the first few days, as this may precipitate embolism. Complete rest in bed for at least six weeks is essential even for the mildest cases, and convalescence must be prolonged. Cardiac stimulants such as camphor are inadvisable. If the patient is nervous and over-anxious bromide is helpful.

CONGESTIVE CARDIAC FAILURE

In congestive cardiac failure, inability of the cardiac muscle to maintain the circulation efficiently results in typical pathological changes in practically all the organs of the body, such changes are the same whatever the cause of the failure, whether associated with valvular disease or due entirely to myocardial degeneration. The treatment of congestive failure is the same whatever its origin may be.

Morbid Anatomy of Congestive Cardiac Failure—The pathological changes found at autopsy are best described under the various systems involved

1 *The Cardio Vascular System*—No detailed description need be given at this point of the pathological changes in the heart, as these are described in the sections allotted to the various types of valvular lesion. It is true, however to say that in congestive failure, whatever its origin, the right ventricle is dilated, with widening of the tricuspid valve, the great veins, as a result of increased difficulty in discharging their contents into the auricle, are dilated, and as a result fluid collects in the subcutaneous tissues, particularly those of the most dependent parts. Stasis in the dilated auricles or veins frequently leads to the formation of thrombi which may become wholly or partially detached and lead to embolism and infarction. Clots from the right auricle will lodge in the lungs, while those from the left side of the heart may produce infarction anywhere in the systemic circulation. Further, as a result of the increased venous pressure, passive effusions may collect in the serous cavities most commonly in the peritoneum, and less frequently in one or both pleural cavities, and in the pericardium. In severe cases there may be a generalised anasarca, involving in addition, the abdominal wall and the scrotum.

2 *The Lungs*—In chronic cases the lungs are tougher and redder than normal, and the condition is described as *red induration*. On histological section many of the alveoli are filled with exudate containing red cells and the so-called heart failure cells, which include blood pigment. Sometimes actual areas of hæmorrhage occur in the substance of the lung, known as *pulmonary apoplexy*. In addition, there may be infarcted areas which result from the occlusion of a branch of the pulmonary artery by an embolus consisting of a detached portion of thrombus formed in the right auricle. Such infarctions are roughly wedge shaped, and are found with their base on the visceral layer of the pleura, the infarcted areas are red in colour, and the pleura overlying them shows evidence of a pleurisy, sometimes complicated with an effusion which may be blood stained. On section of the lung much œdema fluid may be expressed particularly at the bases. In the bronchi there is an excess of blood stained secretion.

3 *Alimentary System*—Owing to the condition of general venous stasis characteristic changes occur in the liver, and to a less extent, in the spleen and alimentary canal. The liver is usually described as *nutmeg* in type, owing to its peculiar

appearance on section, there is considerable general enlargement and the capsule is tense, on section the cut surface consists of a large number of dark red points surrounded by a greyish or yellowish zone, the red areas are around the central veins of the lobule, while the outer zones of the lobule are yellow from fatty degeneration.

The spleen is firmer than usual owing to increase in its fibrous tissue elements, and in colour a dark purple, it is rarely enlarged, and sometimes may be smaller than normal. Recent or old infarcts are common.

The mucous membrane of the alimentary canal particularly in the stomach is dark and congested, petechial hæmorrhages may be present with an increased secretion of mucus and sometimes minute erosions of the mucous membrane, which may lead to hæmorrhage into the cavity of the stomach. Gangrene resulting from embolism of the mesenteric vessels is a rare complication.

4 *Kidneys*—The kidneys in congestive failure are often described as "india rubber," owing to the increased toughness of their substance. They are somewhat enlarged, markedly firm, and dark in colour. On section the cortex is wide and well differentiated from the medulla. Scarring due to old or recent infarcts may be found.

5 *The Central Nervous System*—Cerebral softening may result from infarction due to clots from the left auricle or fragments of vegetations detached from the mitral or aortic valves. This may occur in chronic valvular disease, but is more common in subacute bacterial endocarditis.

Signs and Symptoms of Congestive Cardiac Failure—A patient with severe congestive failure presents so typical a picture that no long description is necessary. Breathlessness is perhaps the most constant and striking feature, even at absolute rest dyspnoea is obvious, and the patient breathes far more comfortably while propped up (*orthopnoea*). He is markedly restless and is constantly making attempts to cough which are often ineffective or may produce a little frothy and sometimes blood stained sputum. The restlessness and coughing prevent sleep, and in consequence troublesome insomnia adds to the burden thrown upon the heart. The complexion varies from pallor to cyanosis and the latter is specially marked in the ears, the tip of the nose and the extremities. Although the subjects of valvular disease are usually thin this may be masked to some extent by oedema and the abdomen is distended by ascites and enlargement of the liver. Abdominal pain and vomiting are common, the former is due

to the enlarged and tender liver, and the latter to the chronic gastritis produced by the passive venous congestion in the gastric mucous membrane. The veins are markedly distended with blood, and those in the neck may be seen pulsating. In the more severe cases profuse sweating may be a striking feature, and the patient is cold and clammy, while the mouth temperature is recorded as subnormal.

Emboli, consisting either of fragments of clot from the auricles or of portions of valvular vegetations, may produce symptoms depending on the localisation of the infarcts produced. Sudden pain in the chest, with dyspnoea, hæmoptysis and later a pleural rub, indicate infarction of the lung, which may be followed by a pleural effusion often blood stained. Emboli from the left side of the heart may produce sudden hemiplegia, due to a cerebral embolus. Pain in the region of the spleen and occasionally a rub may indicate infarction. Other less common sites of embolism are (1) peripheral vessels in the limbs, especially the legs, (2) retinal vessels, (3) mesenteric vessels, (4) renal arteries, resulting in transient hæmaturia and albuminuria. Embolic manifestations such as those described above occur most frequently in congestive failure and mitral stenosis or in subacute bacterial endocarditis, of the latter condition they may be an outstanding feature.

Such is the clinical picture of severe congestive failure, but sometimes one particular group of symptoms may predominate. Thus, for example, indigestion and vomiting may suggest an abdominal condition, and the true pathology of the symptoms only becomes apparent on finding a cardiac lesion with an enlarged and tender liver.

In some cases of cardiac failure mental symptoms may be a prominent feature. Apart from restlessness and anxiety the patient becomes the victim of terrifying dreams and hallucinations, which may lead on to a state of complete confusion and disorientation. When these symptoms develop early, the patient needs careful watching lest he jump out of bed and injure himself. Occasionally violent delirium develops. As a rule severe mental symptoms are of grave prognosis.

On physical examination apart from the signs of valvular disease, there is found to be increased cardiac dullness to the right of the sternum, indicating dilatation of the right side of the heart. On examination of the chest the respirations are frequent and shallow, the percussion note at the bases of the lungs is impaired and, if pleural effusions are present there may be a board like dullness, on auscultation râles are heard over the bases, and sometimes signs of a more

generalised bronchitis are present. The liver is easily palpable and may extend as low as the umbilicus, it is markedly tender, and may be felt to pulsate. The spleen is rarely palpable. If ascites is present fluid may be detected by a thrill and movable dullness, often the amount of distention and eversion of the umbilicus may make the diagnosis of ascites obvious without any physical examination.

The pulse is always rapid, and often markedly irregular owing to the presence of auricular fibrillation (*vide p 511*). Other arrhythmias, particularly extra systoles, are frequent accompaniments of congestive failure.

In the milder cases of congestive failure when the patient has only few symptoms, a careful examination may detect physical signs which point to the true diagnosis. Coarse rales at the bases often occur long before any œdema or marked dyspnoea, and sometimes tenderness under the right costal margin may indicate the early stages of venous congestion of the liver, even though there is no obvious enlargement of that organ. Increased venous pressure may be demonstrated by the failure of the veins of the arms to collapse rapidly when the limb is elevated above the level of the manubrium. Congestive failure however mild necessarily implies some degree of breathlessness at rest.

TREATMENT OF CARDIAC FAILURE

It has been emphasised that the most important factor which determines the onset of cardiac failure is the condition of the heart muscle. If the muscle remains even relatively undamaged the presence of chronic valvular disease will produce few if any symptoms. So great is the reserve power of the healthy myocardium that even moderately severe grades of mitral and aortic valvular disease are not incompatible with reasonable longevity and activity. It must, however, be borne in mind that the presence of chronic valvular disease nearly always indicates that at some time in the past there has been more or less severe inflammation of the myocardium, and thus, coupled with the extra strain thrown on the heart muscle by valvular disease, is extremely likely to lead ultimately to cardiac failure. In chronic valvular disease, myocardial insufficiency frequently arises in late middle life as a result of the gradual impairment of the functional capacity of the heart muscle, in common with that of the skeletal muscles.

The Prophylaxis of Cardiac Failure—The treatment of acute carditis has already been discussed elsewhere, but there remains the problem of the patient who after an acute carditis usually due to rheumatic fever, is left with a heart damaged by valvular disease

1 *Avoidance of Further Attacks of Rheumatic Fever*—If the patient is a child there is a grave risk that further recurrences of acute rheumatism may cause additional damage to the heart and it is therefore all important that the patient should be shielded as far as possible from such attacks. If possible, the child should be removed to healthy surroundings in the country, and all factors such as overcrowding and defective nutrition should be eliminated. Unfortunately under present social conditions this is usually impossible except among the rich. If the patient is of the industrial class, something may be gained by sending him to a special school for rheumatic or invalid children.

2 *Occupation*—The question of occupation is an important one in patients with damaged hearts. All occupations which involve heavy manual work are highly unsuitable. The problem mainly arises among the poorer class of patient. Clerical or business work of some kind is sometimes a solution. High altitudes and hot climates are to be avoided.

3 *Personal Hygiene*—Focal infection must be avoided. The teeth should be kept in good order and all carious or dead teeth removed, as infection from such a source may produce infective endocarditis. Wholesale tonsillectomy in rheumatic patients has nothing to recommend it, but if the tonsils are a focus of chronic sepsis they should be removed. When no signs of failure are present an ordinary diet is satisfactory. As regards exercise, though it must be realised that a patient with a damaged heart has a diminished cardiac reserve it is most important from the point of view of general health that reasonable exercise and fresh air should be encouraged. The patient's own sensations form the best criterion as to the amount of exercise to be allowed. Fatigue and breathlessness will be a sufficient warning that the heart muscle is being overtaxed. In all cases with chronic valvular lesions, strenuous competitive games such as football, boxing and running must be forbidden but more moderate exercise such as walking or golf are often beneficial. More sleep is needed by a cardiac patient than by a healthy person and all factors which produce insomnia must be avoided.

4 *Mental Hygiene*—It is most important that a patient with a valvular lesion should not be allowed to drift into

chronic invalidism through too much concentration on his disability. While it must be explained to him that reasonable precautions must be taken, he should be encouraged to regard himself as capable of a normal and useful life. Not infrequently patients with valvular disease have a haunting fear that they may suddenly drop dead, and it should be explained to them that there is no risk of this occurring.

Treatment of Incipient Failure—Having dealt with what might be termed the prophylactic treatment of cardiac failure, we must now consider the case of the patient with a damaged heart, who shows early signs of cardiac failure. This may be manifested in various ways, such as undue dyspnoea on exertion, tachycardia or arrhythmia, or digestive disturbances. The occurrence of such symptoms is an indication that the capacity of the heart muscle is being overtaxed, and a warning that, in the absence of adequate steps to adjust the life and régime of the patient to his condition, more severe symptoms will develop. As a rule it is desirable that the heart should be rested by confining the patient to bed for a few days, though when the symptoms are slight, prolonged or absolute rest in bed is unnecessary. In cases with threatened failure it is most important to avoid respiratory infections, such as bronchitis, owing to the extra work thrown upon the heart by coughing. Adequate clothing and the avoidance of draughts and damp will contribute to this object, and in times when epidemics of catarrhal disease are prevalent, places where infection is likely to be contracted, such as churches and theatres, should be avoided. An attempt must also be made to minimise unnecessary exertion, such as climbing of stairs. Pregnancy must be avoided at all costs, as it is likely to produce cardiac breakdown. If the symptoms of impending failure are gastric, the diet should be modified by taking small meals of dry food, with some limitation of the fluid intake, starchy foods such as puddings must not be taken owing to the flatulence which may result. The question of the administration of drugs is a debatable point. Provided the pulse remains regular, it is doubtful whether anything is gained by giving digitalis, but a general tonic such as strychnine or nuxvomica may be useful. If the patient's work involves manual labour, he should be advised to obtain a more sedentary occupation.

TREATMENT OF CONGESTIVE CARDIAC FAILURE

We now have to deal with the problem of established cardiac failure. The patient is breathless even at rest, œdema is

present, and there may be effusions in the pleural or peritoneal cavities, cyanosis is often marked, and the condition is obviously one in which life itself is in danger. In a large proportion of cases auricular fibrillation is present. The objects of treatment are threefold—the procuring of complete rest, the relief of the venous congestion, and the restoration of a more normal pulse rate. These points are dealt with in detail below.

1 Rest.—Needless to say, absolute rest is essential. Usually dyspnoea prevents the patient lying flat, and a sitting posture in bed is found to be most comfortable. He should be prevented from doing too much for himself, and satisfactory progress depends mainly on careful nursing. Patients with marked orthopnoea are sometimes more comfortable propped up in an arm chair. The most valuable drug for procuring adequate rest in a patient with severe heart failure is morphia. This should be given in a dose of $\frac{1}{4}$ gr hypodermically, if there is oedema of the lungs $\frac{1}{16}$ gr of atropine should be given simultaneously. With such treatment the patient rapidly ceases to be restless and will often obtain a reasonable period of sleep, from which he awakes marvellously improved. No attention need be paid to the theoretical risk of depressing the heart with morphia, and the drug should never be withheld in restless and anxious patients with severe cardiac failure. In milder cases, or after improvement has taken place, chloral bromide, or paraldehyde may be given by mouth.

2 Relief of Venous Congestion.—In severe congestive failure, whatever the lesion, the patient is usually cyanosed, the veins distended, and the cardiac dullness is increased to the right of the sternum. The symptoms may often be relieved, at any rate temporarily, by venesection, and generally this is most useful if done as soon as possible after the patient is seen. From 1 to $1\frac{1}{2}$ pints of blood should be withdrawn. The simplest and cleanest method is, after compressing the upper arm to insert a needle into a vein at the bend of the elbow and connect it to a suction bottle. With a needle of reasonably wide bore there is usually no difficulty with clotting. The withdrawal of a pint or so of blood at once lessens the strain on the heart and produces an immediate and remarkable improvement. Venesection is of particular value in congestive failure secondary to chronic bronchitis and emphysema. The most dramatic improvement occurs in patients whose red cell count is well over five millions.

3 Slowing of the Pulse.—In most cases of severe congestive failure, especially with mitral stenosis, auricular fibrillation is present, and the ventricle is contracting at a rate of 120 a

minute, or over. In such instances, it is important to reduce the heart rate as rapidly as possible, and fortunately in digitalis we have a drug which can effect this object (*vide p. 514*)

There are certain other points that must be considered —

1 *Diet* —During the acute stage of failure, owing to the tendency to vomiting, there is no object in attempting to force food upon the patient. A diet of not more than two pints of milk a day, given in small amounts at frequent intervals, is usually satisfactory. The amount of fluids should be limited, especially when there is much œdema, and the amount of salt in the diet should be reduced to a minimum, though a salt free diet is unnecessary unless all other measures have failed. When improvement has taken place meals should still be frequent, small, and dry in character.

2 *Use of Oxygen* —Oxygen is undoubtedly of value if the patient is cyanosed. It should be given continuously through a nasal catheter after being bubbled through warm water. By moistening the gas, it prevents excessive drying of the naso-pharynx, and it also enables the attendant to see at a glance that a steady stream of gas is passing into the catheter. A mask or oxygen tent may be unsatisfactory in cardiac failure, if it produces a subjective feeling of suffocation, which more than counterbalances the value of the oxygen.

3 *Edema, Ascites, and Pleural Effusion* —In all severe cases of congestive failure there is some degree of anasarca. As a rule, under the influence of rest and digitalis this rapidly diminishes, but sometimes the condition is more obstinate. Ascites which seriously embarrasses respiration should be relieved by paracentesis. Pleural effusions are seldom large, but if dullness extend above the angle of the scapula, aspiration often relieves the patient. For œdema of the legs, acupuncture should only be performed if digitalis and the mercurial diuretics have failed and the skin is very tense and the amount of fluid in the tissues very great. Acupuncture should never be attempted unless the skin is absolutely free from infection, as sepsis may produce disastrous results. When anasarca is a prominent feature, the administration of Guy's pill is often beneficial. This consists of mercury pill B.P. gr. 1, powdered squill gr. 1, digitalis leaf in powder gr. 1, and extract of hyoscyamus to gr. iv, one pill may be taken three times a day. As a diuretic, theobromine sodium saccharate is sometimes useful, given for several days in doses of 15 gr. thrice daily.

Remarkable improvement often results from the use of the mercurial diuretic, mersalyl, salyrgan, or neptal. This may be

given by intravenous or intramuscular injection. A preliminary dose of 1 c c of a 10 per cent solution is given intramuscularly. If this does not produce signs of intolerance, such as hæmaturia or severe diarrhœa, a course of injections at four-day intervals may be started, giving 2 c c of the solution. Intramuscular injections are effective but the drug can also be given intravenously diluted with 5 c c of saline. The diuretic effect is enhanced by giving ammonium chloride by mouth (30 gr in capsules) two hours before injection. The diuretic effect lasts approximately twenty four hours, but 100 oz of urine or more may be passed in this period. At the same time fluids are restricted to 40 oz or less if possible. It is most important *not to give* these drugs if there is evidence of renal failure. The moderate albuminuria, which so often occurs in congestive failure, does not, however, contraindicate its use.

4 *Cardiac Stimulants*—The multiplicity of drugs to which a tonic action on the heart muscle has been ascribed is sufficient proof that none of them has any specific action. As a general principle it is true to say that repeated hypodermic injections of "cardiac tonics," whether they consist of camphor, strychnine, adrenalin, or other drug, do more harm than good to a patient who is severely ill. Alcohol is sometimes useful not so much from any direct action upon the heart as from its tendency to induce sleep and to allay restlessness and anxiety. It is best given as brandy or champagne.

After-treatment of Cases with Cardiac Failure—Once a severe cardiac breakdown has occurred, the patient will never be fit for any work which involves much physical exertion. It is, however, remarkable what a striking recovery may take place, and patients, even with established auricular fibrillation, may live in comparative comfort for many years. Fibrillation calls for the *continued use of digitalis* in quantities sufficient to keep the heart rate about 70. During convalescence from acute congestive failure, exercise must be begun very gradually, at first passive movements should be started while the patient is still in bed, and these are soon followed by active movements. Great improvement in the exercise tolerance may be gained by a course of progressive remedial exercises under the supervision of an expert in the subject. All the precautions which have been already described above for patients with threatened cardiac failure must be observed, particularly as regards the avoidance of respiratory infections.

Pregnancy and Heart Disease—In dealing with this subject there are two generally accepted propositions: firstly, that auricular fibrillation should be a complete bar to pregnancy,

secondly, that chronic valvular disease without any evidence of failure is compatible with satisfactory pregnancies and labour provided these are not too numerous nor follow in too rapid succession. The difficult problems in connection with pregnancy and heart disease arise in that class of woman where, with a valvular lesion, there are slight indications that all is not well with the heart muscle, in other words, in cases of threatened cardiac failure. If the doctor is called upon to advise as to whether such a patient should run the risk of pregnancy, the answer should certainly be in the negative. Unfortunately, however, as a rule pregnancy has already occurred before advice is sought, and the problem to be decided between the obstetric surgeon and the physician becomes not whether pregnancy is desirable, but how its presence is to be dealt with. The answer will depend largely on the stage of pregnancy that has been reached when the patient is first seen. If she is not beyond the third month, termination of the pregnancy is without danger, but in the later months induction involves probably little less risk than labour at term. On the whole, it may be said that there is a tendency to overrate the danger likely to result from pregnancy, unless the patient has or has had a definite cardiac breakdown. In patients with auricular fibrillation pregnancy, if allowed to go to term, results in the mother's death in approximately a third of the cases.

The treatment of pregnant women with damaged hearts is important. During the last few months of pregnancy they should be practically if not completely confined to bed, and under the influence of rest, and perhaps digitals, the outlook as regards a satisfactory termination is much improved. It is most important that the second stage of labour should not be unduly prolonged, but decision as to the method of delivery must be left to the obstetrician.

The anxiety for a first child and the patient's social circumstances must be taken into account in deciding whether to advise for or against pregnancy. No woman with organic heart disease, however sound the heart muscle may appear to be, should as a rule be allowed to go through more than three pregnancies. Should there be any persistent diminution in the exercise tolerance following a pregnancy, no further risks should be run.

PERIPHERAL CIRCULATORY FAILURE

Peripheral circulatory failure is the term used for circulatory disturbance in which there is a diminution in the venous return

to the heart, this being due primarily to failure of the peripheral bed to retain its contents, or to loss of peripheral vascular tone resulting in failure of the blood to return to the heart or finally to an actual diminution in volume of the circulating blood. In congestive heart failure there is a diminution in the venous return secondary to a decrease in the cardiac output with a tendency to engorgement of the veins. In peripheral circulatory failure, the veins are relatively depleted.

Peripheral circulatory failure results from many different mechanisms, the chief one being the diminution in volume of circulating blood. The classical clinical picture exhibiting peripheral circulatory failure is that of surgical shock as seen following trauma, hæmorrhage, surgical operation, or perforation of a hollow viscus. The characteristic features are a pale, damp cold skin, showing a cyanotic tinge, and rapid shallow respiration. The pulse is usually rapid and of very low tension, the blood pressure is always low, the pupils are dilated and react sluggishly to light, the urinary volume is diminished.

It is now generally accepted that the type of circulatory failure which is so commonly seen in conditions of diabetic acidosis, Addison's disease, acute pancreatitis, acute diffuse peritonitis, severe vomiting or diarrhoea, and severe burns is due primarily to peripheral circulatory failure in which there is a diminution in the volume of circulating blood. The clinical appearances in these various conditions are practically identical with the classical picture of surgical shock. Many theories have been put forward to explain the mechanism of peripheral circulatory failure. The chief factors at work in the different conditions are —

1 A neurogenic reflex causing a peripheral vasodilatation, *e.g.*, as seen in primary surgical shock and a perforated viscus.

2 The diminution in the volume of circulatory blood brought about by one of three mechanisms

(a) The loss of large quantities of fluid *e.g.* in conditions of severe hæmorrhage, vomiting, or diarrhoea.

(b) The loss of salt where both the sodium and the chloride molecules play an important part, *e.g.*, in diabetic acidosis, Addison's disease.

(c) The loss or extravasation of plasma, *e.g.*, in diffuse peritonitis and severe burns.

In some cases profuse perspiration and hyperventilation also play a part in diminishing the volume of circulatory blood.

It is important to realise that not infrequently there may be a combination of cardiac (central) failure and peripheral

failure Of chief interest in this connection are coronary thrombosis, pulmonary embolism, and acute infections For example, in the initial attack of coronary thrombosis, it is rare to find signs of congestive cardiac failure, but usual to find the patient in a typical state of shock Later on, as the state of shock passes off and the damaged heart has to deal with an increasing volume of blood returning from the periphery, the typical signs of venous engorgement begin to appear, and the picture of congestive cardiac failure develops

The mechanism of peripheral circulatory failure in myocardial infarction is probably identical with that of the primary surgical shock associated with trauma Fluid is retained in the relaxed small vessels with a resultant depleted venous return to the heart

In pulmonary embolism the clinical picture is a variable one, both cardiac and peripheral factors being present in varying proportions If the embolus is a large one and causes complete obstruction of the pulmonary artery, then death is almost instantaneous and is due to an acute heart failure In cases where massive embolism is incomplete, death is usually delayed and in these cases there is a combination of heart failure and shock When shock is the outstanding factor, the patient is pale and covered with perspiration, and the pulse is almost imperceptible, when the cardiac factor is predominant there is engorgement of the veins of the neck, intense cyanosis, and rapid enlargement of the liver

In acute infections also both peripheral circulatory failure and cardiac failure may be found Originally the circulatory collapse in acute infection was attributed to cardiac failure, but it is now generally accepted that apart from rheumatic fever and diphtheria the circulatory failure is usually due to a peripheral mechanism In those cases where cardiac failure is the predominant feature, it is probable that the heart has already been damaged by arteriosclerosis or other disease prior to the acute infection Cardiac failure in acute infections is shown by the increase in venous pressure resulting in dyspnoea out of proportion to the fever, and engorgement of the liver However, the findings are usually complicated by the presence of peripheral circulatory failure, and in this event the clinical picture is similar to that of surgical shock together with the features of the particular infective disease The skin is pale and sweating and the cyanosis present has a greyish tinge, being counterbalanced by the pallor The extremities are cold and there is no dyspnoea The superficial veins are collapsed and the venous pressure is low It is probable that

the mechanism of the circulatory collapse in the acute infections is also due to a diminution in the volume of the circulating blood, the mechanism of which is not yet fully explained.

Circulatory Failure in Pneumonia—It is generally agreed that congestive heart failure is unusual in patients who develop lobar pneumonia with a healthy heart, and the severe dreaded circulatory collapses heralding death in this disease are due to a peripheral circulatory failure. The pathogenesis of this failure is not clear, but is possibly related to a toxic effect on the capillaries.

Circulatory Failure in Diphtheria—In diphtheria, circulatory failure may be either cardiac or peripheral and often the two mechanisms act together. In some cases sudden death, dyspnea, cyanosis, venous engorgement, and edema point directly to primary cardiac failure, for ample evidence is found at autopsy of extensive myocardial lesions. In others however, there is evidence of peripheral circulatory failure as well, as shown by the low venous pressure and a diminished venous return to the heart.

Circulatory Collapse in Typhoid Fever—As in pneumonia circulatory collapse is usually peripheral in origin, the systemic veins are collapsed, and symptoms and signs of venous engorgement are absent.

In most general infections, except rheumatic fever and diphtheria, the reaction of the heart and circulation is similar to its reaction to pneumonia and typhoid fever.

Treatment of Peripheral Circulatory Failure—Treatment is that given for ordinary surgical shock. The patient should be thoroughly warmed and be given hot drinks, and the foot of the bed should be raised. Saline and glucose solutions may be given by the intravenous, subcutaneous, or rectal route. Intravenous "drip saline" or intravenous injection of plasma or serum may give dramatic results, strychnine, pituitrin, coramine, adrenalin and ephedrine are often effective. Continued administration of oxygen is generally useful.

CONGENITAL HEART DISEASE

One of the striking features of congenital heart disease is the apparent absence of any correlation between the actual deformity present and the signs and symptoms displayed by the patient. Even with intense cyanosis there may be no murmurs, and, conversely, well marked physical signs may be accompanied by no apparent disturbance in the circulation.

and no discomfort. It is to be borne in mind, also, that congenital defects in the structure of the heart are usually multiple, and less often occur singly. A further feature of great clinical interest is the high incidence of infective endocarditis in these cases. Even when the anatomical abnormality is so slight that it gives rise to no disturbance in the circulation and throws no extra strain on the myocardium, for example, supernumerary cusps, or two cusps in place of the normal three, infective endocarditis with characteristic vegetations is prone to become implanted on the abnormal valve.

Congenital disease of the heart may be defined as a condition in which there are present in the heart and great vessels certain anomalies of structure which have arisen either through arrest of development or possibly through disease occurring during intra uterine life. Whether such anomalies lead to circulatory disturbances depends on their nature. In many cases the defects are incompatible with life, in others, the anomaly may give rise to no disturbance of function, being an accidental autopsy finding, such as two or four aortic or pulmonary cusps, patent foramen ovale, or dextrocardia.

Symptoms—Symptoms of congenital disease of the heart may be present from birth or may develop later. Cyanosis is usually the first sign of most types of congenital heart disease, and is present in nearly all severe cases. It is so characteristic that the terms "blue baby" and congenital heart disease are practically synonymous. It is most marked in the face, ears, hands, feet, and mucous membranes. Among the factors responsible for the cyanosis are (a) a mixture of arterial and venous blood, (b) deficient oxygenation in the lungs, (c) general venous engorgement. There is usually a marked increase in the red cells, up to as many as 11,000,000, the specific gravity of the blood is abnormally high and the percentage of hæmoglobin raised. Hæmorrhages from the mucous membranes may occur, and clubbing of the fingers and toes is exceedingly common. Chronic cough and easily induced breathlessness are striking features, and as a rule the child is undergrown, weakly, and succumbs early. If adult life is reached, pulmonary stenosis is probably the main defect. Loud murmurs are usually present and the heart is enlarged, particularly to the right. Clubbing, cyanosis, cardiac enlargement, and a murmur render congenital heart disease almost a certainty, the precise nature of the abnormality may be impossible to diagnose. It must be remembered that striking cyanosis may be produced by methæmoglobinæmia or sulphæmoglobinæmia (*vide p. 369*). In these patients, however, there is no dyspnoea.

Congenital Pulmonary Stenosis—With advanced grades of this condition clubbing and cyanosis are marked, the precordium is often bulging, and the cardiac impulse heaving and diffuse in character. A systolic thrill and murmur may be present over the pulmonary area, the second sound being feeble or absent. Usually other defects are also present, such as patent foramen ovale, patent ventricular septum, patent ductus arteriosus, or anomalies in the position of the aorta and pulmonary artery. The common combination of pulmonary stenosis, patent ventricular septum, dextro position of the aorta and right ventricular enlargement is known as Fallot's tetralogy.

Patent Foramen Ovale and Patent Ventricular Septum.—No physical signs are pathognomonic of these conditions, and they cannot therefore be diagnosed with certainty during life. If the opening is of moderate size a harsh systolic murmur may be heard to the left of the mid line in the third and fourth spaces. With severe symptoms of congenital heart disease and no clear indication of the lesion, patent ventricular septum should be suspected, communications of this type between the right and left sides of the heart may enable an embolus known to originate in a peripheral vein to reach a systemic artery with the production of so called "paradoxical embolism."

Patent Ductus Arteriosus may be found alone or in combination with other lesions. It is a short thick trunk connecting the pulmonary artery (left branch) and the aorta. When persisting throughout life it is commonly associated with pulmonary stenosis, transposition of the great vessels, or stenosis of the aorta. Enlargement of the right ventricle is a constant accompaniment. Cyanosis and clubbing are not so common in this condition as in other congenital affections, and the diagnosis depends almost entirely on the presence of a harsh murmur of maximum intensity in the second left interspace. The murmur persists usually throughout systole and diastole, with systolic accentuation. It is transmitted upwards and to the left, and may be well heard in the left interscapular region. It is commonly accompanied by a thrill and a low pulse pressure or sometimes by a "water hammer" pulse.

Dextrocardia—The heart is on the right side as the result of transposition of the viscera, the stomach and spleen being on the right and the liver on the left side. Very rarely the heart is alone transposed. Dextrocardia has no clinical significance, but must be distinguished from a heart displaced to the right by intrathoracic disease. As it is inherited as a Mendelian recessive character it is more common in the offsprings of first cousin marriages.

Coarctation of the Aorta—This congenital anomaly produces a characteristic clinical picture. By coarctation is meant a stenosis of the aorta between the left subclavian artery and the ductus arteriosus. The lumen of the aorta may vary from a simple narrowing to complete obliteration. The characteristic clinical features of these cases are high blood pressure in the arms and upper half of the body, cardiac enlargement, and unusual prominence of the superficial arteries, particularly round the scapulae. There may be delay between the radial and femoral pulses. The blood pressure of the upper and lower limbs differs more widely than is usual. Loud murmurs at the base or over the aorta behind are not uncommon. The ribs, when examined by X rays, may be notched by the enlarged anastomosing vessels. Post mortem an elaborate anastomosis is found between the branches of the aorta above and those below the narrowing, the anastomosing vessels showing marked hypertrophy.

THE EFFORT SYNDROME

(Disordered Action of the Heart, D A H, Soldier's Heart)

There is a special group of patients that seek medical aid because of symptoms generally attributed to derangement of the circulatory system, but in whom no objective signs of disease can be elicited. That is, they complain of undue breathlessness on the slightest exertion, pain round the heart, and palpitation, which may often be referred to as pseudo angina, cold and blue extremities, and fainting attacks. An exacting clinical examination, aided by X ray and laboratory methods, reveals no evidence of anatomical change in the heart or great vessels. The question arises, is there any organic disease present in the cardiovascular system? Abnormal as the patient undoubtedly is, where or what is the root of his trouble? What is the prognosis?

It has been pointed out that excessive exercise normally gives rise in a healthy individual to breathlessness, palpitation, giddiness, faintness, a sense of fatigue and exhaustion, and sometimes even precordial pain. This syndrome is the normal physiological response to effort. Persons suffering from myocardial disease also show a typical physiological response to exercise, but whereas the healthy man requires considerable exertion before distress is felt, the sick man requires very much less. Hence a low exercise tolerance always suggests cardiac disease, and if examination reveals an enlarged heart,

a precordial thrill, a diastolic murmur, a persistent high blood pressure, or general arteriosclerosis, we know that disease is present. It is when the subjective symptoms of disease are unaccompanied by objective signs that the difficulty arises, and in recent years it has become usual to classify these cases under the diagnosis of "the effort syndrome."

Ætiology.—The majority of persons exhibiting the effort syndrome are constitutionally handicapped, often they are undersized, poorly developed, low spirited creatures. They are described by their friends and parents as having always been weakly. Often there is a personal or family history of nervous instability. A second group comprises those who have undergone a period of increased mental and physical stress, a third group includes those constitutionally weakened by some illness such as rheumatic fever, dysentery, or pneumonia, or in whom there is focal sepsis localised to teeth, tonsils, or alimentary tract. A final group is composed of cases of early tuberculosis, or of those wrongly diagnosed who really have the beginnings of a slowly progressive cardiac disease already implanted.

The symptoms are, briefly, breathlessness at rest or after mild exercise, without any sign of cyanosis. The breathing may be hurried even during sleep, but breathlessness is confined to the waking moments. Fatigue and exhaustion are complained of, there is no desire to do anything as the slightest effort exhausts. Precordial pain is common, it may vary in intensity from an ache to a continuous gnawing or it may come on only after exercise. Precordial tenderness is frequent. The expression is anxious, and exaggeration of symptoms is common. Heart consciousness or palpitation is invariably complained of, fainting attacks may come on at unexpected moments or at some trivial ordeal, such as a medical examination or a subcutaneous injection. Such attacks should not be confused with true epilepsy. Giddiness after exertion along with a marked fall in blood pressure is apt to occur, and headache, sweating, numbness of the extremities and dermatographia are occasionally seen. The pulse rate rises rapidly at the slightest provocation, with a markedly slow return to normal.

This description of the symptoms shows clearly that the condition is closely related to an anxiety state.

Physical Signs.—The diagnosis rests on the absence of physical signs of cardio vascular disease. In a large percentage systolic murmurs are present, but are not accompanied by thrills. Provided the murmur is certainly systolic in time and is unaccompanied by other signs of disease, it may be disregarded. With a rheumatic history it is well to delay

final judgment until the patient has been under observation for a considerable period

Prognosis and Treatment—Having excluded the possibility of organic disease such as phthisis, focal sepsis, and Graves's disease, it is possible to give a good prognosis. The patient should be reassured, his general health enhanced by such obvious measures as proper food, congenial work, general tonics, a course of graduated exercises may prove beneficial. A large percentage, however, including those in whom nervous instability is a feature, show little improvement after years of treatment

HYPERTENSION AND ARTERIOSCLEROSIS

Considerable confusion has arisen in connection with arterial disease and hypertension owing to the multiplicity of terms that have been employed in describing the pathological and clinical conditions involved. From the purely pathological point of view three varieties of arterial change may be recognised: (1) arteriosclerosis, (2) arteriolosclerosis, and (3) Mönckeberg's sclerosis. Often all three of these may coexist in a single patient but more frequently there is a preponderance of one type of change which may have an important bearing on the symptoms presented.

Arteriosclerosis—This condition may involve both the large arteries, especially the aorta, and the smaller vessels. The arteriosclerotic changes are especially striking in the descending thoracic and abdominal aorta. The coronary arteries are very frequently involved, as are also the main branches of the aorta and the arteries at the base of the brain. The condition primarily affects the intima, the early atheromatous lesions appearing as slightly elevated yellow streaks. These areas later become necrotic, and atheromatous ulcers form which frequently become calcified.

The result of widespread atheromatous change in a large artery, such as the aorta, is a great diminution in its elasticity, which is sometimes associated with some dilatation of its lumen. Aneurysms due to arteriosclerotic changes occasionally arise in the carotid, but in the aorta they are almost invariably due to syphilitic aortitis (*vide p. 576*) and the atheromatous change produces no more than a general dilatation of the aorta. Sometimes it may spread down to involve the aortic cusps, thus rendering the valve incompetent. In the smaller arteries such as the coronaries proliferation of the intima and the formation

of atheromatous plaques may so much reduce the lumen that eventually it may become completely occluded by formation of thrombus

Arteriolo sclerosis.—In contrast to arteriosclerosis, where even in the smaller arteries the changes are visible to the naked eye, in arteriolo sclerosis the changes involve only the arterioles, and are visible only on microscopical examination. The pathological process occurs most frequently and most strikingly in the kidneys, and for a description of the histological appearances reference may be made to p 715 where the nephroscleroses are described. Apart from the kidneys similar changes are found in the spleen, pancreas, and liver, but not in the arterioles of the lungs, myocardium, or skeletal muscles.

Although arteriolo sclerosis is a purely histological finding, it is of great importance, as it is the earliest and sometimes the only change in the arterial system in essential hypertension.

Möackeborg's Sclerosis—This type of arterial disease affects mainly the arteries of the lower limbs of elderly persons. Here the media becomes calcified, often in a series of rings, producing the "pipe stem" artery, which can often be visualised in an X-ray owing to the presence of calcium. The elasticity of the arterial wall is lost, and as a result the blood supply to distal parts is diminished. This may lead to intermittent claudication or gangrene of the toes.

The Normal Blood Pressure—Our knowledge of the blood pressure in normal persons has been obtained mainly from the statistics of life insurance examinations. The average pressure in the brachial artery at varying ages shows a gradual increase in both systolic and diastolic levels with advancing age. Wide variations of blood pressure readings are, however, compatible with perfect health. In general it may be said that for adults a systolic blood pressure below 100 mm of mercury or persistently above 160 mm is likely to be an indication of disease. Even in the same individual there may be variations of as much as 20 mm or more from time to time, depending on such factors as posture, excitement, exercise and meals. On the whole, the diastolic pressure is less liable to variations than the systolic. The normal range of diastolic pressure is from 70 to 90 mm. Diastolic pressures above 100 mm are always pathological.

The technique of blood pressure estimations can be learnt only by practical experience, and no attempt will be made here to give in detail the procedure to be adopted with various types of sphygmomanometers. It is, however, important to realise that the first reading may be too high, more particularly

if the patient is nervous or excited. With a mercury sphygmomanometer there is little possibility of error in the instrument itself, but dial types of machine readily become inaccurate, and should be repeatedly checked.

ESSENTIAL HYPERTENSION

Although high blood pressure has long been known to be a concomitant of renal disease and of arteriosclerosis, the recognition of a clinical condition in which a raised blood pressure is an apparently primary condition is mainly due to the late Sir Clifford Allbutt, who coined the term *hyperpiesia* to describe such cases. Perhaps simpler is the term *essential hypertension*.

By no means all persons with high blood pressure can be regarded as suffering from essential hypertension, for it is well recognised that in all forms of renal insufficiency there is a considerably elevated blood pressure. Also certain rare disorders of the endocrines, such as basophil adenoma of the pituitary (*vide p. 287*) or tumours of the adrenals (*vide p. 281*) may produce high blood pressure. Nevertheless essential hypertension is far more commonly encountered than is high blood pressure due to all other causes put together. Moreover it is difficult, if not impossible, to draw clear lines of distinction between essential hypertension and arteriosclerosis, for essential hypertension sooner or later is always accompanied by a varying degree of arteriosclerosis, and many of the symptoms attributed to hypertension are really the result of ischæmia, which results from localised arteriosclerotic changes. It probably is not an exaggeration to say that most cerebral vascular disease, the greater part of chronic cardiac disease, and perhaps not an inconsiderable proportion of renal disease are the ultimate results of essential hypertension.

Pathology—The most prominent post mortem findings in a patient who has died during the course of essential hypertension are cardiac hypertrophy, mainly of the left ventricle, and arteriosclerotic kidneys. The naked eye and histological appearances of the latter are fully described on p. 715. In addition there will be a varying degree of arteriosclerotic change depending on various factors such as the age and the duration of hypertension.

Ætiology—Although hypertension and its sequelæ probably account for a quarter of all deaths which occur after fifty years of age, but little is known as to the underlying causes of the condition. Many theories have been put forward, most of them with little or no experimental or clinical evidence for their

support. Thus among other theories it has been maintained that the hypertension is due to pressor substances circulating in the blood, to disturbances of the endocrines, particularly the adrenals and pituitary, and to disorders of protein metabolism.

The one outstanding feature of essential hypertension is that at any rate in a very high proportion of cases there appears to be an inherited and constitutional basis. That hypertension and its sequelæ, such as cerebral hæmorrhage and cardiac disease, "run in families" is proved up to the hilt not only by statistics but by the personal experience of every medical practitioner. This does not, of course, mean that essential hypertension is necessarily due to hereditary influences, nor does it explain the mechanism of the production of hypertension in a patient in whom hereditary and constitutional factors are present which predispose to the condition.

It is extremely difficult to estimate the importance of environmental factors, such as the increasing stress of every day life, tobacco, and alcohol. Although it is true that in the last half-century there appears to have been an increase in arterial disease and its sequelæ, this may be partly due to increasing longevity of the population and more accurate diagnosis. Thus it must seem remarkable to the student of to-day that the clinical features of coronary occlusion were not recognised until 1924. Nevertheless it seems probable that prolonged and excessive indulgence in food, drink, and tobacco may have an adverse effect on the blood pressure.

Although almost from its name essential hypertension was thought to be independent of renal disease, in recent years Goldblatt has succeeded in producing chronic hypertension in animals by constricting the renal arteries. The diminution in renal blood flow so produced renders the kidneys relatively ischæmic, and the ischæmic kidneys perhaps produce a pressor substance, which, when it passes into the circulation, gives rise to hypertension. Possibly, therefore, in essential hypertension the primary change may be an ischæmia of the kidneys due to an antecedent sclerosis of the renal arterioles (renal arteriolosclerosis).

Symptoms—As it is impossible to assess with any accuracy the degree to which hypertension is associated with arteriosclerotic changes in any individual case, it is difficult to determine what symptoms are to be attributed purely to hypertension. It is by no means rare to discover at a routine examination a systolic blood pressure of 200 mm or more with a correspondingly raised diastolic pressure in a person in apparently perfect

health In fact many people in the forties with much over average blood pressure are extremely fit, active, and energetic It is indeed doubtful whether a high blood pressure *per se* produces any symptoms When these occur in a patient with essential hypertension they are due not so much to the raised pressure as to the secondary changes in the heart and other organs resulting from diminution in the blood supply

The manifestations, therefore, which may be ascribed to hypertension and its sequelæ are very varied and need not be dealt with in detail, as their clinical features are described elsewhere The more important, apart from malignant hypertension (*vide p 574*), are tabulated below —

1 *Cardio-vascular System*

- (a) Coronary sclerosis—angina (*vide p 541*)
Coronary occlusion (*vide p 546*)
- (b) Left ventricular failure—attacks of cardiac asthma (*vide p 572*)
- (c) Congestive cardiac failure (*vide p 549*)
- (d) Arrhythmias, especially extra systoles, also auricular fibrillation and heart block
- (e) Aortic regurgitation due to atheroma of valve cusps
- (f) Intermittent claudication and gangrene

2 *Nervous System*

- (a) Headaches (probably due to cerebral arterio sclerosis)
- (b) Vertigo and tinnitus
- (c) Cerebral hæmorrhage and, less commonly, thrombosis
- (d) Mental symptoms (*vide p 1016*)
- (e) Hypertensive encephalopathy (*vide p 786*)

3 *Eye*

- (a) Retinal arteriosclerosis
- (b) Papillædema

4 *Renal System*

- (a) Albuminuria and casts
- (b) Impaired renal function (unusual)
- (c) Uræmia (rare)

Most of the conditions tabulated above need no further discussion in this connection, as they are dealt with elsewhere It is, however, necessary to describe the features of left

ventricular failure, which are very prone to occur in hypertensive heart failure

Left Ventricular Failure—In all cases of essential hypertension there is hypertrophy of the left ventricle. This can often be shown clinically by the forcible heaving apex beat, which is displaced to the left and may be confirmed by an orthodiagram. Cheyne Stokes breathing is often observed. Eventually the hypertrophied left ventricle becomes insufficient. When this happens the most dramatic of the symptoms which result are attacks of breathlessness usually described as *cardiac asthma*. These are attacks of paroxysmal dyspnoea, which often occur at night and waken the patient. In its more acute forms cardiac asthma is accompanied by acute pulmonary oedema in which copious frothy sputum is coughed up, it is often blood stained. Although he has no pain the patient is acutely distressed by the feeling of suffocation. The attacks last on an average one hour and the patient is left exhausted. Although death during the first paroxysm is very unusual the occurrence of repeated attacks of cardiac asthma are always of ill omen. Cardiac asthma may also be seen in atherosclerosis, aortitis and aneurysm, and rather similar attacks of dyspnoea though not as a rule nocturnal, may occur with neoplasms of the lung. Cardiac asthma resembles superficially bronchial asthma, though it tends to occur in older people and is more alarming and distressing. Rather similar attacks may be an early symptom of carcinoma of a bronchus. With left ventricular failure there is no evidence of peripheral venous stasis, oedema or enlargement of the liver unless congestive failure is superimposed. With the onset of left ventricular failure there is often a lowering of the systolic pressure, which falls out of proportion to the diastolic thereby rendering the pulse pressure unduly low.

Retinal Changes with High Blood Pressure—Owing to arteriosclerotic changes the arteries appear narrower than usual, are tortuous and reflect a bright line of light along their course, the so called "silver wire" appearance, also where they cross the veins the latter appear to be constricted. Retinal haemorrhages are common, and there are often white areas which vary very much in size and number. The degree of impairment of vision depends mainly on the location of the lesions. In malignant hypertension (*vide p 581*) there is papilloedema in addition to retinitis.

Treatment and Prognosis of Hypertension—As we have no certain knowledge regarding the aetiology of essential hypertension and arteriosclerosis, nor of the mechanism by which

they are produced, it can be understood that the situation as regards treatment is unsatisfactory. At the best it can be but palliative.

Attention must be paid to the general régime. Focal infection should be dealt with, especially in hyperpiesia. Most of the patients will be found to be leading too strenuous a life, especially as regards mental activity. Although it is not usually necessary to advise a complete cessation of business activities, the hours of work must be curtailed, and, above all, mental fatigue and anxiety must be avoided. Physical strain is liable to produce serious symptoms, but reasonable exercise is beneficial; the amount of exercise advisable is best regulated by the patient's own sensations.

Great stress has been laid on the diet in cases of high blood pressure. If the patient is overweight there is often benefit from a general limitation of the diet, which produces a loss of weight. On the other hand, it is unnecessary and often harmful to render life a misery by too strict a dietetic regime. Meat should be much curtailed but not omitted; plenty of fresh vegetables and fruit are advisable, as these tend to combat constipation; liquid paraffin is also useful from this point of view. The use of alcohol and tobacco should be limited, but here again it is unnecessary to render the patient unhappy by a complete veto, which in any case is likely to be disregarded.

While it is necessary to emphasise to the patient the importance of adhering strictly to instructions as to régime and diet, it is important to prevent a continual concentration of his mind on his blood pressure. The use of the sphygmomanometer should be restricted, as too frequent estimations lead only to anxiety and give no helpful information. It is always unwise to allow the patient to know the exact blood-pressure readings.

No drugs have much permanent effect in reducing a high blood pressure, and even were it possible to reduce it to normal, it is doubtful whether much benefit would result. Potassium iodide, in doses of about 20 gr. a day, has a traditional reputation, but its efficacy is probably much overrated, except in syphilitic cases. Nitrites reduce the blood pressure temporarily, but are only useful in allaying urgent symptoms such as cardiac pain. Bromides or luminal may help the patient to sleep and to attain that attitude of philosophic calm which should be the object of treatment. In the plethoric type of patient the removal of 20 oz. of blood by venesection often produces an improvement, and may be repeated at intervals.

The outlook as regards life is very variable, and all patients

with a blood pressure of over 200 are precarious lives. A fall in the systolic pressure is often an unfavourable sign, as it may indicate the onset of cardiac failure. Death may occur at any time as the result of cerebral complications or of cardiac failure. On the other hand, life is often prolonged for many years even with pressures of over 200, so that it is justifiable to give a reasonably good prognosis to the patient himself, though the relatives should be warned of the dangers attendant on the condition.

Treatment of Left Ventricular Failure—The recognition of this condition is of great importance because it demands immediate treatment by venesection, digitalis, and diuretics as well as by rest and morphine. Whenever there is gross oedema of the lungs or much cyanosis, venesection should be performed and 15 to 20 oz. of blood should be removed. Digitalis is of value in left ventricular failure as well as in right-sided failure with systemic congestion. Mercurial diuretics are often effective when pulmonary oedema is present. The amount of rest required in cases of left ventricular failure is often underestimated, as in an early attack there may be an apparently rapid recovery. The patient needs generally to rest for at least a month and may even require to be in bed for this length of time.

Malignant Hypertension—Whereas in the great majority of instances of essential hypertension death occurs from sequelae involving the heart or brain, in a small proportion, probably less than 5 per cent., the renal arteriosclerosis is accompanied by necrosis and endarteritis of the renal arterioles. This occurs most often in patients under fifty years of age and sometimes even in relatively early adult life. The diastolic pressure is much elevated, rarely below 130. The clinical picture of malignant hypertension is completely different from that of other forms of hypertension. The most prominent symptoms are those due to increased intracranial pressure, consisting of very severe and intractable headache, nausea and vomiting and sometimes epileptiform convulsions and other nervous symptoms as described under the heading of Hypertensive Encephalopathy (*vide p. 786*). On examination papilloedema is invariably present, and the CSF pressure is raised to 250 to 350 mm. of water. The clinical picture may simulate a cerebral tumour. In addition to the symptoms due to increased intracranial pressure, there is a progressive deterioration of renal function. Albumin and red cells are found in the urine in varying amounts, and the blood urea ultimately rises. The specific gravity tends to become fixed at about 1010.

The renal aspects of malignant hypertension are discussed on p 715. In the later stages there is often a tendency to hæmorrhage, including epistaxis and purpura.

The outlook in malignant hypertension is for practical purposes hopeless. Once severe symptoms have become manifest death may occur within a few months, though sometimes in less acute cases life may be prolonged for several years. All treatment, apart from palliative measures for the relief of symptoms, is unavailing.

DISSECTING ANEURYSM OF THE AORTA

In this relatively rare type of aneurysm there is a rupture through the intima so that blood is effused into the media, the layers of which become split. In most cases the tear into the media is situated in the arch of the aorta and the effused blood tracks through the media both towards the aortic valves and down the descending aorta. The dissection may involve the carotids and subclavian, and often extends downwards into the abdominal aorta. The condition most often occurs in males of middle age and over, who suffer from high blood pressure. Sudden exertion, such as lifting a heavy weight, appears to be a precipitating cause. Syphilis is not a factor.

The chief symptom is sudden and very severe pain, most often substernal, but sometimes high in the epigastrium, in addition there is often vomiting and collapse, and not infrequently the condition may simulate a severe coronary occlusion or even a perforated peptic ulcer. The dissection may spread up the carotid and lead to cerebral symptoms. Narrowing of the lumen of arteries may cause the disappearance of arterial pulsation in the limbs, most often in one or both legs. Owing to the loss of blood supply the legs may become cold or even appear to be paralysed.

In about 80 per cent of cases the condition proves fatal within a few days, and sometimes it may be the cause of sudden death. Often the effused blood bursts through into the pericardium or pleural cavity.

No treatment is available except morphia and complete rest.

SYPHILIS OF THE AORTA AND AORTIC ANEURYSM

Aneurysms of the thoracic aorta are almost invariably syphilitic, as is valvular disease beginning in middle life and confined to the aortic valves. Even during the secondary stage

of syphilis changes are already in progress in the arteries more especially in the aorta and cerebral vessels

Ætiology—Though syphilitic aortitis and aneurysm of the aorta occur occasionally in females, the majority of cases are males between the ages of forty five and sixty. As a rule a latent period of approximately twenty years elapses between the primary infection and the development of symptoms referable to aortic disease

Pathology—The part of the vessel most frequently affected by syphilis is the ascending portion and the arch, less commonly the descending thoracic aorta is involved, and syphilitic disease of the abdominal aorta is extremely rare

In syphilis aortitis, the primary pathological change consists in involvement of the minute vessels which supply blood to the arterial wall these are known as the *vasa vasorum*. Surrounding these are found collections of lymphoid and plasma cells which are sometimes necrotic and resemble gummatous nodules seen elsewhere. The lumen of the vessels is often diminished or obliterated owing to the proliferation of the intima. As a result the blood supply to the wall of the aorta is deficient, and the more highly specialised tissues—the muscle and elastic fibres—degenerate and are replaced by fibrous tissue. On microscopical examination the media is found to contain irregular strands of fibrous tissue, and the circular elastic fibres are fragmented. Possibly as a compensatory change due to weakening of the media, the intima is thickened and fibrous. On naked eye examination the interior of the aorta appears wrinkled with fine longitudinal rugæ, irregular folds, and small nodular swellings. Unlike atheroma syphilis does not produce ulceration or calcification of the intima though atheromatous changes may also be present.

Similar changes may occur in the aortic valves and cause scarring and thickening which render them incompetent. When the process involves the orifices of the coronaries it may lead to narrowing at the point of entry, though the syphilitic process rarely extends beyond the mouth of the coronary vessels.

As a result of syphilitic aortitis, the vessel loses its elasticity and the strength of the coats of the artery is diminished. The fibrous tissue which largely replaces the muscular and elastic fibres becomes stretched as the result of the continued arterial pressure and dilatation may occur with the formation of a saccular or fusiform aneurysm. The syphilitic origin of aortitis of the type described above has been conclusively proved by the discovery of the *Spirochæta pallida* in the walls of the vessel.

Symptoms of Syphilitic Aortitis.—In its earlier stages syphilitic aortitis is usually symptomless, and at autopsy the condition is often unexpectedly discovered. In the absence of complications, such as aortic regurgitation and aneurysm, the most frequent symptom is a sense of substernal oppression, sometimes this may be little more than a feeling of discomfort, but it sometimes amounts to pain, which is comparable with that of angina pectoris. In fact, in syphilitic aortitis the anginal syndrome (*vide p 541*) is not uncommon. The pain and feelings of oppression often occur after exertion or excitement, but when the condition is well established the attacks may take place at any time. In addition attacks of cardiac asthma may occur (*vide p 572*).

Physical examination of a patient with syphilitic aortitis is often negative. A systolic murmur is occasionally heard, presumably due to dilatation of the artery above its point of origin. There may be abnormal pulsation in the neck or in the suprasternal notch. The diagnosis of the condition rests, however, mainly upon the symptoms, a positive Wassermann reaction, with or without a history of syphilis in earlier life, and sometimes a characteristic X ray appearance of the aorta. If aortic regurgitation is present, the physical signs associated with that lesion will be detectable. It is often possible to demonstrate by radiographic methods a dilatation of the aorta which fails to produce definite physical signs.

It is impossible to lay too much stress on the importance of considering the possibility of syphilis in every non-rheumatic patient over forty years of age who develops aortic valvular disease or symptoms which might be referable to the aorta. Needless to say, if treatment is to be effective it must be begun as early as possible, before irreparable damage has occurred, such as disease of the valves or aneurysm.

AORTIC ANEURYSM

It has already been shown that aortic aneurysm is but an advanced stage of syphilitic aortitis. Although aneurysm is almost invariably syphilitic, probably other factors are involved in addition. The disease is at least ten times more common in men than in women, and this is due to heavier muscular work and an increased incidence of syphilis. Whether alcohol is a factor is more doubtful. At least 90 per cent of patients suffering from aneurysm of the aorta give a positive Wassermann reaction in the blood.

Aneurysms of the aorta have been classified into three

pathological types, saccular, fusiform, and dissect. Saccular aneurysm is due to a localised weakness in the wall, the fibrous tissue gradually stretches until a sac is formed, which may ultimately become larger than a tennis ball and which communicates with the lumen of the aorta by an opening which may be comparatively small. In the fusiform type of aneurysm there is a general dilatation of the vessel which may involve a considerable length of the ascending aorta and the arch. Dissecting aneurysm is described elsewhere (vide p. 575).

The signs and symptoms of aneurysm vary with its position, size, and rate of enlargement. Aneurysms of the descending and abdominal aorta are relatively rare compared with those that involve the ascending aorta and the arch.

Symptoms and Signs—These are mainly due to pressure on surrounding structures, but in addition the patient may suffer from pain of an anginal type or attacks of cardiac asthma which are due to syphilitic aortitis. As a general statement it may be said that aneurysms of the ascending aorta and arch produce marked physical signs and relatively few symptoms while aneurysms of the descending thoracic aorta produce severe symptoms with but few physical signs.

Aneurysm of the Ascending Aorta—When an aneurysm occurs close above the valves there is likely to be aortic regurgitation, and ultimately rupture into the pericardium may occur. If higher up it may press upon the chest wall and eventually erode the ribs. There is dullness to the right of the sternum in the second and third interspaces, and often as the aneurysm becomes larger there may be definite bulging in this region with a tumour showing expansile pulsation. A systolic murmur is often heard over the aneurysm. Pain is sometimes severe.

Aneurysm of the Arch—When the arch of the aorta is involved symptoms and physical signs are as a rule numerous and due to pressure on surrounding structures. They may be classified as follows:—

1 *Pressure on the Trachea and Lungs*—The aneurysm may become adherent to the trachea and produce a partial constriction. In such cases the well known sign termed tracheal tug can be elicited. The patient is examined with the head thrown well back and the observer's fingers are pressed firmly upon the cricoid cartilage. If tracheal tug is present the cricoid will be felt to be drawn downwards with each heart beat. Pressure on the trachea and the left bronchus may lead to infection of the lung, which the

ultimately becomes consolidated or gangrenous, or abscesses may form in it. Sometimes rupture into the lung leads to a fatal hæmoptysis, which may be preceded by the coughing up of blood stained sputum. The aneurysm may also rupture into the pleural cavity with fatal results.

2 *Pressure on Veins*—Compression of the superior vena cava occasionally produces congestion of the face and head, and sometimes of the arms, or a collateral circulation through the mammary and epigastric veins. These phenomena are, however, more common with mediastinal tumours than with aneurysms.

3 *Pressure on Nerves*—The left recurrent laryngeal nerve is often involved, and this results in laryngeal irritation or paralysis of the left vocal cord. A harsh brassy cough is produced by irritation, while a hoarse voice indicates paralysis. Sometimes this may be the earliest detectable sign of aneurysm. Pressure on the sympathetic at the root of the neck may lead to inequality of the pupils and of the palpebral fissures.

4 *Inequality of the Radial Pulses*—If an aneurysm involves the origin of the innominate artery or of the left subclavian, the mouth of the vessel may be partially obstructed, hence the radial pulses are unequal in volume or are not synchronous.

5 *Pressure on the Oesophagus*—Dysphagia as a result of aneurysm is very rare, as the oesophagus is usually pushed to one side rather than compressed. Occasionally rupture occurs into the oesophagus with a rapidly fatal result.

Aneurysm of the Descending Thoracic Aorta—In these cases, which are fortunately comparatively rare, the predominant feature is pain due to erosion of the spine, with irritation of nerve roots. The bodies of the vertebrae are often eroded, but the more resilient intervertebral discs remain unabsorbed. The pain is extremely severe and persistent and is felt around the chest and upper abdomen in the course of the affected nerves. Physical signs are often indefinite, but occasionally a pulsating swelling may be felt over the back or a localised systolic murmur heard, compression of the lung or a bronchus may give typical signs.

Aneurysm of the Abdominal Aorta—The commonest site is immediately below the diaphragm, but the condition is far less frequent than is aneurysm of the thoracic aorta. An aneurysm high up may produce no palpable tumour, and the diagnosis is very difficult or impossible. There is severe and persistent epigastric pain, which is unaffected by diet, and can only be relieved by large doses of morphia. Most

abdominal aneurysms are due to arteriosclerosis rather than syphilis

Diagnosis—In many cases of aneurysm the diagnosis is obvious from the presence of a pulsating tumour. When in doubt, X ray examination should usually decide the question. The patient is best examined erect in the left lateral position. If an aneurysm is present, a shadow will be seen encroaching on the posterior mediastinum. On examination with the fluorescent screen, pulsation can be detected.

Prognosis—About 50 per cent of cases of thoracic aneurysm terminate by rupture into the lungs, pleural cavity, pericardium or œsophagus. Death may also occur from cardiac failure or respiratory complications. If untreated life is rarely prolonged more than a few years but with anti syphilitic treatment given early the outlook is considerably improved.

Treatment of Syphilitic Aortitis and Aortic Aneurysm.—Pathological changes in the aorta begin during the secondary stage of syphilis, and thorough treatment during the primary and secondary stages of the disease are probably effective in diminishing the likelihood of the development of aortitis in later life. However, even when manifest changes have occurred in the aorta, provided the heart is not failing, the progress of the disease may be arrested by vigorous treatment with potassium iodide, mercury, and the salvarsan group of drugs. The patient should be kept at rest in bed, but there is no object in the severe restrictions of food and drink which were popular methods of treatment in the past. Potassium iodide should be given in increasing doses up to about 150 gr daily, after four to six weeks of iodide treatment intravenous injection of neoarsphenamine may be commenced, the first dose should be extremely small (0.15 grm), and the dosage must be increased very gradually until full doses are being given. If this precaution is adopted there is little risk of severe reactions. For severe pain morphia may be necessary.

For the relief of the paroxysmal attacks of dyspnoea which occur in syphilitic aortitis amyl nitrite may be tried but morphia and atropine are often required.

ANEURYSMS OF PERIPHERAL VESSELS

These may be classified under the following headings—

1 **Traumatic**—If an artery is punctured, blood may be effused into the surrounding tissues, and pulsation occurs in the swelling thus produced. Such an aneurysm is often described as a "false aneurysm," owing to the fact that the

coats of the artery take no part in the formation of the wall of the aneurysm

2 **Mycotic**—In infective endocarditis and pyæmic conditions, implantation of micro organisms in the arterial wall may lead to a local erosion and weakening of the artery, which is known as a mycotic aneurysm. These are frequently multiple

3 **Intracranial**—These are described elsewhere (*vide p 787*)

4 **Arterio-venous**—This term is applied to aneurysms in which there is communication between an artery and a vein. The majority are due to gunshot wounds. The communication is sometimes large enough to produce a water hammer type of pulse

THROMBO ANGITIS OBLITERANS

Thrombo angitis obliterans is an inflammatory condition which affects the arteries and veins of the limbs and results in their occlusion by the formation of a thrombus which eventually undergoes organisation. The disease is practically confined to the male sex. Originally described by Buerger as occurring almost entirely among Jews in England there is no special racial incidence. The great majority of the patients are between thirty and forty years of age. Occasionally it appears to have a familial incidence.

Little is known of the ætiology of the condition. Syphilis is certainly not a factor but there is often a history of excessive smoking. From a pathological point of view the primary change is an acute inflammatory condition of all the coats of the vessel wall. As a result thrombosis occurs, later the clot becomes organised and the affected vessel forms a fibrous cord. Frequently areas of thrombosis may be seen in the superficial veins of affected limbs. These form localised red areas which are tender on palpation.

The symptoms of thrombo angitis obliterans are due to interference with the blood supply of the affected limbs. The onset is usually insidious and the patient's first complaint is of pain in the calves which is induced by exercise and relieved by rest. Usually one leg is first affected but in the course of time both become involved. In later stages there may be severe pain burning in character in the feet and legs quite apart from exercise. Localised areas of thrombo phlebitis may also occur. Less commonly the disease may involve the arms. The patient is able to walk a certain distance, often not more than a hundred yards without discomfort and is

then compelled to stop by the onset of pain in the calves after a few minutes rest the symptoms disappear, and he is able to walk a little further until the pain returns. This group of symptoms is known as *intermittent claudication* but in itself it is not characteristic of thrombo angitis obliterans in fact considerably the most common cause of intermittent claudication is arteriosclerosis. As the disease progresses the distance which the patient can walk before the onset of pain gradually decreases.

On examination of the affected leg the pulses in the posterior tibial and dorsalis pedis arteries cannot be felt and the foot is livid while in the dependent position. By elevating the limb towards the perpendicular when the patient is lying down ischaemia of the extremity is produced and the skin becomes blanched. After some years trophic changes occur in the skin and ultimately dry gangrene may result.

Occasionally thrombo angitis obliterans is associated with *erythromelalgia*, a rare condition in which there is pain redness and swelling in the feet or hands particularly when the limb is in a dependent position.

Treatment and Prognosis—In few diseases have so many different treatments both medical and surgical, been advocated. Unfortunately there is little evidence that genuine or permanent improvement results from any one of them. Undoubtedly rest in bed is beneficial, but relapse usually occurs when the patient tries to resume a normal life. Often radiant heat or diathermy relieves the pain. The following methods of treatment have been advised—

1 *Buerger's Passive Exercises*—The affected limb is elevated to about 60 degrees above the horizontal and is allowed to rest in this position for the minimum time necessary to produce blanching (usually $\frac{1}{2}$ to 3 minutes). The foot is then allowed to hang down until reactionary hyperaemia or rubor sets in (usually 2 to 5 minutes). The limb is then allowed to rest in a horizontal position for about 5 minutes and the cycle is then repeated. The exercises are carried out for one hour at a time and should be repeated several times daily. The object is to promote collateral circulation.

2 *Protein Shock Therapy*—Fever is produced by the intravenous injection of a typhoid vaccine (5 to 50 million organisms). The object of the treatment is to produce vaso-dilatation of the extremities. Unfortunately arterial thrombosis occasionally occurs with disastrous results.

3 *Alternate Suction and Pressure*—The limb is enclosed in an airtight chamber and subjected to alternate negative and

positive pressures. The apparatus required is elaborate but favourable results are claimed after prolonged treatment.

4 *Surgical Treatment*—Periarterial sympathectomy and ligation of the femoral vein have both proved useless, but sometimes favourable results have followed lumbar ganglionectomy, especially when vasospasm is present apart from organic obliteration of the vessels.

When pain in the foot is severe, a peripheral nerve block with alcohol or section of the sensory nerve produces anaesthesia for about six months and often gives great relief.

When gangrene occurs, especially if it is complicated by infection amputation high up may be required.

No drugs have any specific action but beneficial results have been claimed for alcohol, injection of tissue extracts, thyroid, acetylcholine and other substances. It is most important to avoid trauma to the feet and particularly burns by hot water bottles. The patient may live for many years and occasionally spontaneous cure may occur, but in the majority of cases in spite of all forms of treatment the condition gradually deteriorates. Death may occur from intercurrent illnesses or toxic absorption from gangrene.

VASOMOTOR DISORDERS

RAYNAUD'S DISEASE

This term is applied to a condition in which the fingers and toes are affected by an intermittent spasm of the arteries, which may ultimately reduce the blood supply to such an extent that gangrene results.

Ætiology—Nothing definite is known of the factors that produce Raynaud's disease. It occurs far more commonly in females than in males, and the onset of symptoms is usually before middle age. No constant pathological changes are found either in the central nervous system or in the vessels of the affected areas and it is assumed that the manifestations of the disease are due to vascular spasm. In long standing cases the vessels show intimal thickening with narrowing of the lumen.

Symptoms.—The changes seen in Raynaud's disease are always symmetrical, usually affect both hands and feet, and are always worst in cold weather. Two stages are described—

1 *Local Asphyxia*—This most commonly affects the fingers and toes, which become cold and numb, and closely resemble the condition which may be brought about by severe cold. The

vasoconstriction which produces such symptoms may last from a few minutes to several hours. The fingers, toes and sometimes the ears and nose become intensely livid and congested, pain is often severe and the affected parts may become insensitve to touch. When massaged in an attempt to restore circulation they become dead white, thus in the case of the fingers giving rise to the term "dead fingers."

2 *Local Gangrene*—The cold asphyxiated parts become anæsthetic and black in colour as gangrene sets in. Usually the occurrence of gangrene is limited to the tips of the fingers and toes.

Diagnosis—Vasomotor phenomena in the fingers when exposed to cold often result in a condition of pallor and numbness, which resemble the stage of local syncope in Raynaud's disease. Whether this condition, which is often familial, should really be classed as mild Raynaud's disease is doubtful. In many cases the tendency to 'dead fingers' persists through life, and no other symptoms of the disease develop.

There is little risk of confusion between Raynaud's disease and the gangrene due either to arteriosclerosis or to thromboangitis obliterans. Raynaud's disease is invariably symmetrical and affects chiefly females, while gangrene due to either arteriosclerosis or thromboangitis is most often met with in males and is primarily unilateral. Intermittent claudication is a prominent feature in the two latter conditions and does not occur in Raynaud's disease.

Treatment—No specific treatment is available, but sometimes calcium lactate in 15-gr. doses thrice daily appears to be helpful. Affected limbs should be kept at rest, warmly wrapped in cotton wool. Permanent residence in a warm climate is often beneficial. Stripping of the periarterial sheaths, often fallaciously termed periarterial sympathectomy, is of no value, but cervical ganglionectomy may result in conspicuous improvement.

ANGIO NEUROTIC EDEMA

In this remarkable but not very uncommon condition circumscribed areas of œdema occur upon the skin and mucous membranes. Any part of the body may be affected, but most commonly the face. The swellings appear spontaneously and are sometimes preceded by itching or burning sensations, their duration varies from a few hours to several days, but both the onset and disappearance of the œdema are remarkably rapid. Usually there are no symptoms beyond local discomfort, due to the swelling of the skin, but sometimes the

attacks are complicated by severe abdominal pain and vomiting which may simulate an acute abdominal condition. The abdominal symptoms are probably due to circumscribed œdema of the mucous membrane in the alimentary tract. If the glottis is affected there is a risk of death from suffocation.

The origin of the disease is unknown but it is usually regarded as allergic or as a vasomotor neurosis. In many instances it is certainly hereditary or familial and Osler records one family in which five generations were affected. The resemblance between the condition and urticaria suggests the possibility that food allergy is a factor.

The treatment of angio neurotic œdema is unsatisfactory particularly in patients with a family history of the disease. When the glottis is affected immediate tracheotomy may be needed. Calcium lactate may be tried but is usually ineffective. Adrenalin usually gives temporary relief.

MILROY'S DISEASE

This disease is also known as Hereditary Œdema and is nearly always hereditary or familial in origin. The swelling is confined to the legs which may be enlarged up to the thighs; the feet are rarely involved. It is sometimes unilateral. The œdema does not pit markedly on pressure and there is no evidence of venous or lymphatic obstruction. The condition is painless and the general health remains unaffected though the great weight of the limbs interferes with normal activity. The firm application of crepe bandages diminishes the swelling and gives much relief. Treatment both medical and surgical is ineffective.

ACROPARÆSTHESIA

In this condition numbness tingling or pins and needles occur in the finger tips without physical signs suggesting organic nervous disease. It occurs most frequently at the menopause in emotionally unstable women. Treatment is usually of little avail but radiant heat and massage may be tried. Thyroid often proves of considerable value.

DISEASES OF THE VEINS

THROMBOSIS

Inflammation or trauma of the wall of a vein leads to a local deposition of blood platelets and the formation of a clot (thrombus). Inflammation of a vein (phlebitis) may be of

two kinds plastic or suppurative, which differ widely in the symptoms produced

Suppurative Phlebitis—This condition is always most serious. The wall of the vein is infected from some adjoining focus of suppuration, and the thrombus which forms within the vein rapidly breaks down, and its infected fragments are discharged into the general venous circulation. This results in pyæmia and secondary abscesses most often in the lungs.

Sinus Thrombosis is described elsewhere (*vide p 509*)

Suppuration in the abdomen, particularly around the appendix may lead to a suppurative pylephlebitis and multiple abscesses in the liver (*vide p 459*)

Plastic Phlebitis—In this condition a thrombus forms, which may ultimately undergo organisation, and the vein becomes a fibrous cord, or canalisation of the clot may open new channels for the flow of blood.

Ætiology—Phlebitis or thrombo phlebitis, as it is often termed, occurs not infrequently without any obvious cause, and is more common in the veins of the legs than elsewhere. Possibly its onset is often due to focal infection, which may be quite unsuspected. Thrombosis of the femoral vein is a relatively frequent complication of typhoid fever or, indeed of any severe general infection such as pneumonia, in such cases the left femoral vein is almost always the one which becomes thrombosed. Following parturition a similar condition may occur—phlegmasia alba dolens or ‘white leg’. In addition to the above, thrombo phlebitis has been attributed to many other diseases, particularly gout. Thrombosis of veins also occurs after operations particularly pelvic operations.

Symptoms—These will naturally vary with the site of the thrombosis. Local pain and tenderness are the earliest and most prominent features. When the affected vein is superficial there is obvious redness and œdema, but on no account should any attempt be made to palpate the vein. Thrombosis of a large vein such as the femoral produces marked swelling and œdema of the limb, which lasts from several weeks to many months or even years.

Some degree of pyrexia is common, but the general symptoms are slight, in marked contrast to suppurative phlebitis. The local pain persists for some days and then gradually subsides. Non-suppurative phlebitis has a good prognosis, provided a portion of clot does not become detached. Such an accident will produce a pulmonary embolism which may be fatal.

Treatment—Complete rest and immobilisation of the thrombosed area are essential. For the pain, sedatives such as

aspirin bromides, chloral, or even morphia may be required. Sodium citrate is sometimes given with the idea of preventing further thrombosis, but its value is problematical. Immobilisation of the affected part must be insisted on for at least four weeks, and massage or palpation must be forbidden during the same period owing to the danger of detaching a clot into the circulation. When there is no obvious cause for the phlebitis, and particularly if thromboses have been multiple, any possible source of sepsis should be eradicated.

Thrombo-phlebitis Migrans—In this condition multiple thromboses occur usually successively in different parts of the body. In addition to the systemic veins those in the lungs may be affected and produce pleurisy and pleural effusion. Even a coronary vessel may be involved. The condition is often accompanied by pyrexia of moderate degree and may last for many months. Often this syndrome occurs as a secondary manifestation in carcinoma, particularly in carcinoma of the lung. Multiple venous thromboses also occur in thrombo-angitis obliterans.

Pulmonary Embolism—Whenever thrombosis occurs in a vein there is a risk of a portion of clot becoming detached. Should this occur, the thrombus passes through the right side of the heart and is eventually arrested at some point in the pulmonary artery or its branches. A large embolus may lodge at the bifurcation of the pulmonary artery and completely stop the circulation of blood through the lungs. Such accidents occur most often about seven to ten days after operations. The patient, who is usually convalescent, suddenly sits up in bed, becomes unconscious and convulsed, and is dead within a few minutes. There is no cyanosis, and the colour is that of a "white asphyxia." Smaller emboli may occlude small branches of the artery and produce localised infarctions of the lung. In such an event there is sudden onset of pain in the chest, dyspnoea, and later slight hæmoptysis and a localised pleural rub. Sometimes a pleural effusion

two kinds, plastic or suppurative, which differ widely in the symptoms produced

Suppurative Phlebitis — This condition is always most serious. The wall of the vein is infected from some adjoining focus of suppuration and the thrombus which forms within the vein rapidly breaks down, and its infected fragments are discharged into the general venous circulation. This results in pyæmia and secondary abscesses, most often in the lungs.

Sinus Thrombosis is described elsewhere (vide p. 509)

Suppuration in the abdomen, particularly around the appendix may lead to a suppurative pylephlebitis and multiple abscesses in the liver (vide p. 459)

Plastic Phlebitis — In this condition a thrombus forms, which may ultimately undergo organisation, and the vein becomes a fibrous cord, or canalisation of the clot may open new channels for the flow of blood.

Ætiology — Phlebitis or thrombo phlebitis, as it is often termed, occurs not infrequently without any obvious cause and is more common in the veins of the legs than elsewhere. Possibly its onset is often due to focal infection, which may be quite unsuspected. Thrombosis of the femoral vein is a relatively frequent complication of typhoid fever or, indeed, of any severe general infection such as pneumonia, in such cases the left femoral vein is almost always the one which becomes thrombosed. Following parturition a similar condition may occur — phlegmasia alba dolens or 'white leg'. In addition to the above, thrombo phlebitis has been attributed to many other diseases, particularly gout. Thrombosis of veins also occurs after operations, particularly pelvic operations.

Symptoms — These will naturally vary with the site of the thrombosis. Local pain and tenderness are the earliest and most prominent features. When the affected vein is superficial there is obvious redness and œdema, but on no account should any attempt be made to palpate the vein. Thrombosis of a large vein, such as the femoral, produces marked swelling and œdema of the limb, which lasts from several weeks to many months or even years.

Some degree of pyrexia is common, but the general symptoms are slight, in marked contrast to suppurative phlebitis. The local pain persists for some days and then gradually subsides. Non suppurative phlebitis has a good prognosis, provided a portion of clot does not become detached. Such an accident will produce a pulmonary embolism which may be fatal.

Treatment — Complete rest and immobilisation of the thrombosed area are essential. For the pain sedatives such as

DISEASES OF THE RESPIRATORY SYSTEM

PHYSICAL SIGNS

SKILL in the detection and interpretation of physical signs in the chest can be obtained only by practical instruction and experience. Accordingly it is not proposed to describe individual physical signs. Those, however, which are likely to be encountered in cases of the more important respiratory disorders will be enumerated and where necessary their significance will be discussed under the various appropriate headings.

DISEASES OF THE NOSE

The Common Cold—This usually originates in the nasopharynx one to five days after exposure to infection, and may spread to accessory sinuses, Eustachian tubes and middle ear, the larynx, and occasionally the trachea, bronchi and lungs. The onset is often indicated by a sensation of chilliness which is followed by malaise, listlessness, and nasopharyngeal catarrh. Headache is common and the digestion may be disturbed. The course varies with the severity of infection and the resistance of the individual, and the duration varies from a few days to some weeks.

Etiology—The liability to infectious catarrh of the upper air passages is common to all ages and races, but is relatively rare in infants and the aged. Exposure to infection is the essential factor, as shown by the freedom from colds in members of Arctic and Antarctic expeditions while out of touch with other communities. Undue exposure to cold and wet weather may often, however, be a precipitating factor.

Bacteriology—It seems probable that a filterable virus as yet unidentified, is the primary cause of the common cold. Secondary infection with bacteria quickly follows. Thus, on culture from a nasopharyngeal swab many different organisms

may be found and these may be responsible later for various complications

Pathology—Catarrh is the manifestation of inflammatory reaction on a mucous membrane. There occurs hyperæmia and a local invasion by leucocytes. The latter exude from the surface together with mucous cells and large quantities of mucus.

Prevention—Some individuals are much more frequently attacked than others. In many cases this is due to local defects in the nose or throat, mouth breathers are notoriously unresistant. Other predisposing causes are unventilated rooms and excessive clothing. Above all, close contact with a sufferer in the active stage of the disease is to be avoided. It is the manifest duty of the latter to isolate himself during the first three days of the disease, and to avoid close contact and kissing until the catarrh has cleared up completely. Of prophylactic value are general ultra violet light baths given throughout the winter. Increasing exposures up to twenty minutes for each bath may be taken twice weekly. Inoculations of anti catarrhal vaccine if given over a period in the autumn and winter may also be of assistance and diminish the risk of complications.

Treatment—At the onset the patient should if possible stay in bed for twenty four hours. After a hot bath he should take a hot drink made of water and sugar with lemon juice or crushed black currants and this should be followed up by 10 gr of aspirin. On the first night sweating should be promoted by sleeping wrapped in a blanket and surrounded by several hot water bottles. Opium in the form of Dover's powder (5 to 10 gr) is a favourite remedy but its value is doubtful.

Swelling of the mucosa may be controlled by instilling into the nostrils every three hours drops of a preparation made by dissolving four grains of ephedrine in an ounce of saline. The discomfort of nasal obstruction may be further relieved by inhalations of benzedrine.

Chronic Catarrhal Rhinitis—Ætiology—In patients with a low resistance chronic rhinitis may follow a series of colds. More frequently the underlying cause is nasal obstruction, the presence of adenoids or chronic infection of an accessory nasal sinus.

Symptoms—The symptoms are discharge of watery or mucoid secretion from the nostrils, and nasal obstruction. Secondary effects may be pharyngitis, laryngitis, and middle ear disease. The mucous membrane of the nose is swollen, especially on the turbinates. At first it is red and soft later it may become pale and tough.

Treatment—Local causes, such as adenoids, polyp, or gross deviation of the septum, may need operative interference. In the absence of these, treatment aims at raising the patient's resistance. Most beneficial, especially for town dwellers, is a change of climate. An autogenous vaccine prepared from organisms found on a post nasal swab is effective in some cases.

Epistaxis—Epistaxis, or bleeding from the nose, is common in young children and in the elderly. In the former, it is usually due to some local cause such as acute rhinitis or trauma, while in old age it is more often due to remote causes such as benign hypertension, chronic nephritis and hepatic cirrhosis. It occurs also in association with valvular disease of the heart, and various forms of anæmia, uræmia, purpura, and scurvy. It is a common symptom in the early stage of enteric fever.

The bleeding arises as a rule from vessels on the anterior part of the nasal septum. In patients suffering from hyperpæsis, heart disease, or uræmia it may be beneficial, in others the loss of blood may do serious harm. Epistaxis is common in hereditary telangiectasia (*vide p. 363*).

In order to stop the bleeding, the patient should be kept still with the head raised. An ice bag is applied to the back of the neck, and the nostril plugged with cotton wool soaked in solution of adrenalin 1 in 2,000.

Intractable epistaxis is best controlled by a pneumatic plug. This consists of an india rubber finger stall, inside which is sealed the end of a soft catheter. The finger stall is inserted into the nose, and inflated through the catheter, which is then clamped. If bleeding continue from a localised area cauterisation with an electric cautery or a stick of silver nitrate should be tried. Blood transfusion may occasionally be required.

DISEASES OF THE TONSILS

Acute Tonsillitis—*Ætiology*—This may occur sporadically or in epidemics. The sporadic variety is seen chiefly in persons with chronic enlargement of the lymphoid tissue of the throat. Epidemics are common in institutions especially hospitals. The causative organism varies but is often a hemolytic streptococcus which is directly communicated from case to case. The disease, though common in children and young adults, is rarely seen in infants or the aged.

Morbid Appearance—The tonsils become red and swollen, the crypts fill with exudate and debris which project from the orifices as pale cheesy masses. The exudate from several

crypts may coalesce to form a yellowish grey patch the surrounding pharynx is more or less inflamed

Symptoms —There is a sudden onset with dull aching pain in the back, and headache. The temperature may rise to 104° on the first day. The face is pale, breath offensive, tongue heavily coated. The cervical lymph glands may become tender and enlarged. The urine is concentrated and sometimes contains a trace of albumen. The throat feels sore and there is pain on swallowing.

As a rule, the temperature falls after three or four days and health is quickly restored. Serious complications such as septicæmia, acute otitis media, acute nephritis, acute rheumatism and rheumatic carditis may occur, especially in children. Less serious complications are a diffuse erythema simulating scarlet fever, fibrositis and erythema nodosum.

Diagnosis —The most certain method of distinguishing tonsillitis from diphtheria is by bacteriological examination which will establish the causal organism, and which should, whenever possible be a routine investigation for these cases. However in diphtheria a firm ashy grey membrane forms, more commonly on one than on both tonsils, soon extends to the faucial pillars and uvula, and is fairly sharply limited in extent whereas the exudate of follicular tonsillitis is loose and yellow involves both tonsils diffusely and rarely extends beyond them. When diphtheria is suspected, treatment must not be delayed pending the report on a swab. Cervical adenitis is more striking in diphtheria than in tonsillitis.

Treatment —The patient should be kept in bed and the diet limited to liquids and jellies. Free action of the bowels should be obtained by means of calomel and salines. The throat may be gently swabbed with glycerinum iodi twice daily and powdered aspirin may be insufflated to relieve pain. If sleep is disturbed Dover's powder, 5 to 10 gr., may be given at night. A mixture containing potassium chlorate and sodium salicylate may be given thrice daily (sod. salicyl gr. \times , sod. bicarb gr. $\times\text{v}$, pot. chlorat gr. \times , syrupus aurant ℥ss , $\text{iq ad } \text{℥ss}$). Chemotherapy should not be employed as a routine measure in these cases. If the infecting organism is shown to be susceptible it may sometimes be desirable to give the appropriate drug in full doses e.g. sulphapyridine $1\frac{1}{2}$ grm doses four hourly for two days then 1 grm t.i.d.s for two days for an adult.

Vincent's Angina —*Ætiology* —This is an ulceromembranous affection of the throat and mouth due to combined infection with the fusiform bacillus and spirillum of Vincent. Infection can be transmitted by drinking utensils.

Symptoms—The lesions may be multiple, resembling follicular tonsillitis, or a single "wash leather patch" may form on one tonsil. The patch is raised and irregular, and bleeding occurs when the slough is detached. The membrane may spread to the fauces or along the gums. The cervical glands enlarge on the side affected. The breath is offensive, dysphagia is common, but pyrexia and constitutional disturbance are very variable. In some cases the slough separates after a few days, and the ulcer quickly heals. In others the lesion persists for many weeks.

Diagnosis—The spiculum, together with the fusiform bacillus, may be identified by microscopical examination of a smear, although it does not grow on ordinary culture media. The lesion may simulate diphtheria, but there is not the same constitutional disturbance. A similar appearance is sometimes seen in agranulocytic angina, and in the pharyngeal necrosis associated with the leukæmias. The chronic form may resemble the mucous patch or tertiary ulcer of syphilis. In cases of difficulty the Wassermann reaction should be done.

Prognosis—There is no danger except when Vincent's angina supervenes on scarlet fever, diphtheria, or some other acute fever.

Treatment—An abundant varied diet is essential. Extra vitamin B₂ (nicotinic acid, 250 mgm daily) and vitamin C may be of help. If there is severe ulceration of the tonsil or persistent gingivitis the oral administration of acotarsol (1 to 4 gr adults, $\frac{1}{2}$ gr children) or intravenous injection of neoarsphenamine may be required, in addition to an iodine mouthwash. In chronic cases, diseased teeth should be extracted.

Peri-Tonsillitis or Quinsy.—*Ætiology*—A quinsy is generally preceded by acute tonsillitis, and results from the inflammation spreading to the tissues outside the capsule of the tonsil.

Symptoms—The condition is generally unilateral, and the swelling pushes the tonsil and soft palate downwards. An abscess forms, and if not incised may burst in four to six days. At first the patient complains of sore throat and great pain on swallowing. Later the cervical glands enlarge and the jaw becomes fixed. Cases have ended fatally from oedema of the larynx, from suffocation brought about by bursting of the abscess during sleep, or from hæmorrhage.

Treatment—In the early stages this is the same as that for acute tonsillitis. Sometimes a quinsy may be aborted by intramuscular injection of anti-streptococcal serum or by giving sulphanilamide. As soon as pus has formed, it should be

evacuated. The soft palate is painted with cocaine, and a guarded bistoury is thrust into it at the point of maximum swelling above the tonsil. A hot compress to the neck affords some relief.

Chronic Tonsillitis—In many children the tonsils enlarge during the period of decay of the milk teeth. This enlargement may persist as a simple hypertrophy in conjunction with adenoid overgrowth, and accentuate the obstruction due to the latter. Removal of the adenoids and establishment of nose breathing will often bring about subsidence of the hypertrophy.

Chronic Septic Tonsillitis is to be distinguished from the above. In this variety the tonsils are not necessarily larger than normal, and in some instances they are contracted and fibrous. The crypts are filled with offensive cheesy material consisting of epithelial cells, pus cells, and organisms. In some cases concretions form known as tonsilloliths.

Symptoms—Locally the condition gives rise to frequent "sore throats" and enlargement of cervical glands. Constitutional disturbance is shown by bouts of pyrexia, anæmia, dyspepsia, and sometimes by fibrositis or polyarthritis.

Treatment—Carious teeth should be extracted and other septic foci about the mouth and nose must be eradicated. If the tonsils do not regain a healthy appearance, but still harbour material after the above measures have been carried out and a suitable period allowed for recovery, then the tonsils should be enucleated. The tonsils are useful organs and form part of the defence against infection; they should be sacrificed, therefore, only when it becomes clear that they cannot be restored to a healthy condition.

Agranulocytic Angina—(Vide p. 358.)

ADENOID VEGETATIONS

Ætiology—The condition occurs in children, chiefly between the ages of three and six years, but is met with occasionally in young infants. It is especially common in England, perhaps owing to the cold damp climate.

Morbid Appearance—The vegetations form a foetated mass on the roof of the nasopharynx. They may extend down the lateral walls, cover the openings of the Eustachian tubes, and partially occlude the posterior choanæ. The lymphoid masses are covered by squamous or columnar epithelium, and there is usually an associated hypertrophy of the tonsils, and cervical adenitis.

Symptoms—As a result of post nasal obstruction, the child

becomes a mouth breather. The "adenoid facies" is characterised by the open mouth, projecting upper lip, narrowed nostrils, and high arched palate. Associated developmental abnormalities of the chest occur, including "pigeon" and "funnel" breast.

Other symptoms of adenoids are backward mentality and inability to concentrate, impairment of hearing, headache, night terrors, and enuresis. Children having this complaint are especially liable to recurrent colds, chronic tonsillitis, otitis media, and chronic bronchitis.

Treatment—This is surgical, the adenoids being removed by means of a curette. After operation, breathing exercises should be practised in order to teach the child to breathe through the nose. Cod liver oil should be taken together with a good mixed diet, and exercise in the open air encouraged.

DISEASES OF THE LARYNX

Acute Catarrhal Laryngitis—*Ætiology*—This condition may be due to the same causes as acute rhinitis, it also follows inhalation of hot or irritating vapours. An attack may be provoked by over use of the voice as in shouting. It is a common symptom in measles and influenza, and may occur in patients with pulmonary tuberculosis quite apart from tuberculous ulceration of the larynx.

Morbid Appearance—The mucous lining of the larynx is swollen and hyperæmic, the cords are pink or red, and there is usually infiltration of the submucosa and muscles resulting in lack of tension of the cords in phonation. The sputum is viscid and may be streaked with blood.

Symptoms—In an adult the chief complaints are of partial or complete loss of voice, an irritating cough and a feeling of soreness in the larynx. There may be slight pyrexia and malaise. In the majority of cases the symptoms pass off in the course of one or two weeks.

In the child there are dangers due to the comparative narrowness of the glottis and the tendency to reflex spasm. During the day the symptoms are seldom alarming, but at night the child may wake in a terror with loud crowing inspiration (laryngitis stridulosa), urgent dyspnoea, and cyanosis.

Treatment—The patient should remain in bed, be forbidden to speak, guarded from draughts, and the atmosphere of the room should be kept moist by means of a steam kettle. Compound tincture of benzoin may be added to the water in the

kettle, $\frac{5}{8}$ to the pint, or steam inhalations of this taken for five minutes three times daily. The cough should be checked by a sedative linctus or lozenge. In children, relief may be obtained from hot compresses to the front of the neck, and by a mixture containing gr 1 of potassium antimony tartrate, or by apomorphine gr $\frac{1}{32}$, injected hypodermically. The child should take small doses of chloral and potassium bromide. In extreme cases intubation or tracheotomy may be necessary.

Membranous Laryngitis—This is almost always diphtheritic, though rarely it occurs with other acute infections. The case should be treated as one of diphtheria even in the absence of bacteriological confirmation.

Œdema of the Larynx.—*Ætiology*—Local causes include acute and chronic infections, mechanical or chemical trauma, or spread of infection from, for example, cellulitis of the neck. General causes are nephritis which accounts for over 10 per cent of cases, other conditions capable of producing anasarca, such as heart failure and lardaceous disease, iodine sensitivity, or an attack of angio neurotic œdema in the tissues of the larynx.

Morbid Anatomy—The œdema affects chiefly the loose submucosa of the epiglottis, the aryepiglottic folds, and the ventricular bands, the vocal cords are little affected. In the septic cases the fluid is purulent, in the others serous.

Symptoms—The patient complains of a feeling as though there were a foreign body in the throat. There is difficulty in swallowing, the voice becomes muffled, and at any time obstruction may ensue with inspiratory stridor. With the laryngoscope the mucous membrane looks pale and tense, the epiglottis swollen and erect, and the aryepiglottic folds form ovoid tumours. Without a laryngoscope these swellings may be detected by examination with the finger. The onset may be sudden, and fatal obstruction may occur in less than half an hour, in other cases the condition arises gradually, but even in these there is danger of a sudden exacerbation.

Treatment—The patient is put to bed, and the air kept moist by means of a steam kettle. Fluids may be given by rectum. To prevent spasm, atropine and potassium bromide are given every four hours. Pilocarpin, gr $\frac{1}{8}$, injected three at intervals of twenty minutes, has led to rapid relief. The œdematous parts may be incised, but if dyspnoea develop, tracheotomy should be performed without delay.

In cases due to angioneurotic œdema a subcutaneous injection of $\frac{1}{1000}$ of a 1% solution of adrenalin should be given, and a spray of 5 per cent cocaine and $\frac{1}{1000}$ adrenalin may be used subsequently.

In œdema due to iodism large doses of sodium bicarbonate should be given

Chronic Laryngitis—Ætiology—This may supervene on acute catarrhal laryngitis, or it may be caused by chronic sepsis in the nose, adenoids, the tonsils or mouth. Other factors are over indulgence in alcohol or tobacco. It is also caused by faulty voice production in those who speak in public, *e.g.*, 'clergyman's throat,' and is common in costermongers, actors and singers.

Symptoms—A frequent irritable cough and scanty viscid sputum are present. The voice is husky or there may be aphonia. The loss of voice is usually most complete in the mornings, and phonation becomes easier when the patient has used the voice for a time. Neither of which features occur in hysterical aphonia.

With the laryngoscope, in the lighter cases, the cords are seen to have lost their clear white definition and to be slightly swollen. In more advanced cases the mucous membrane of the larynx may show local or general thickening, or the cords themselves may be thick and irregular, as described by Virchow under the name *pachydermia larynx*.

Diagnosis—In every case the possibility of tuberculous laryngitis (*vide p.* 129) must be borne in mind, and careful examination of the lungs and sputum should be made. In patients above the age of forty, the condition may be due to carcinoma. In this case the thickening and impaired mobility will be for the most part unilateral.

Treatment—The voice must be rested and sepsis in the nose, throat and mouth eradicated. Alcohol and tobacco are forbidden. A change of climate is often of great value. Cough is subdued by administration of codeine, taken in $\frac{1}{2}$ gr. tablets. In severe cases it may be necessary to paint the cords with astringent solutions.

Syphilis of the Larynx—Syphilitic changes in the larynx are by no means rare. Secondary syphilis may give rise to a mild catarrhal condition, but tertiary lesions are much more serious. They usually take the form of gummatæ in the sub-mucous tissue at the base of the epiglottis, and may break down leaving deep ulcers or in their healing give rise to fibrous cicatrices which bind down the epiglottis and lead to such stenosis that tracheotomy becomes necessary. Congenital syphilis gives rise to similar damage. Neither cough nor pain are commonly present.

Treatment is the same as that of syphilis in its other manifestations, except that potassium iodide should not

be given early. Mercury alone suffices to clear up the swelling.

New Growths of the Larynx — *Innocent tumours* of the larynx may occur at any age. The commonest type is the papilloma which appears as a warty outgrowth, often multiple on the cords or ventricular bands. Fibromata and mucous cysts are less common. The first symptom is alteration of the voice when the cords are implicated. A large tumour will cause dyspnoea by obstructing the airway. The treatment is operative removal.

Malignant growths occur more frequently in men than women usually after the age of forty. Persistent hoarseness in an elderly patient should suggest the presence of a carcinoma. The commonest growth is squamous celled carcinoma seen as a single warty tumour on one cord the movement of which becomes impaired. Death results from ulceration and hemorrhage or from septic complications such as cellulitis or broncho pneumonia.

Treatment — In early cases a complete excision of the larynx may preserve life for years. In many cases great relief may result from the local application of radium.

DISEASES OF THE TRACHEA

Both acute and chronic tracheitis as a rule occur in association with similar inflammation of the bronchi. Tracheitis may also develop in cases of diphtheria typhoid influenza and measles while a particularly acute form of the disease may follow the inhalation of an irritant such as mustard gas. Acute tracheitis gives rise to a sensation of soreness behind the manubrium and sternum and to a paroxysmal noisy raucous cough productive of traces of sputum which are not infrequently blood stained. The clinical course prognosis and treatment of simple forms of tracheitis are essentially those of the corresponding bronchial infection. Tracheitis associated with specific fevers may need special appropriate therapy for which the sections concerned should be consulted.

Tuberculous tracheitis is occasionally found in association with tuberculous bronchitis and leads to local ulceration and formation of granulation tissue. The trachea may sometimes be involved both in congenital and acquired syphilis the typical lesion being a gummatous ulcer which may progress to stricture formation. Vigorous antisiphilitic measures are required at an early stage though as in the case of the larynx iodides should be used with caution. Leprosy and scleroma may also cause stricture of the trachea.

These granulomatous lesions, rare primary tumours, more frequently adjacent neoplasms, such as retrosternal goitre, and inhaled foreign bodies, are sometimes productive of obstruction of the lumen of the trachea.

The symptoms and signs depend upon the extent of the obstruction and upon the rapidity of its development. Thus a foreign body may cause intense distress, cough, increasing dyspnoea which is predominantly inspiratory, stridor and cyanosis, and may rapidly be fatal. On the other hand a slowly progressive stricture gives rise to cough, slowly increasing dyspnoea, and stridor, which is at first only noticeable during sleep.

The diagnosis is confirmed by bronchoscopy, and this procedure is essential for therapy in some instances for example, an impacted foreign body. Treatment is otherwise that of the underlying disease, and is for the most part surgical.

DISEASES OF THE BRONCHI

During expiration the muscle of the bronchi normally contracts so that they shorten and become narrower, while in inspiration the musculature relaxes permitting elongation and widening. With partial bronchial obstruction, therefore, inspiration tends to be less impaired than does expiration, and there is a tendency for the distal area of lung to become distended and ultimately emphysematous. When bronchial obstruction is complete the corresponding area of lung collapses completely as a result of absorption of air in the alveoli by the circulating blood. A further consequence of bronchial obstruction is a proportionate failure of excretion of sputum which invariably results ultimately in infection of the bronchi, bronchioles, and lung of varying severity. The infection commonly occurs while obstruction is partial, it always follows within a few days of complete obstruction of a bronchus, and while it may remain limited to the segment of lung concerned, extension of the process is by no means uncommon.

Bronchial obstruction may be widespread, as in acute and chronic bronchitis or asthma, may involve bronchioles or terminal tubes, as in bronchiolitis and broncho pneumonia respectively, or may be localised to a site on a main bronchus. In the last instance it may be caused by viscid sputum, blood or an inhaled foreign body, by bronchial neoplasms, or by pressure from adjacent tumours, including aneurysm and enlarged mediastinal lymph glands. Localised stricture of a bronchus arising from trauma, kinking, or chronic inflammation will have the same consequences.

Additional sequelæ of bronchial obstruction with its induced atelectasis and pulmonary infection are bronchiectasis, bronchiolectasis various forms of pneumonia, lung abscess, and their complications. The symptoms, physical signs, radiological appearances and other features of the disorder are listed under the headings of these various conditions with which it is associated.

BRONCHITIS

Bronchitis is the commonest disease of the respiratory tract. It may be defined as an inflammation of the lining membrane of the larger and medium sized bronchi, and may be set up by inhalation of irritating vapours, but in the great majority of cases it is the result of infection. The air passages are provided with an elaborate defence against invasion by foreign organisms. Their lining membrane secretes mucus, which is in itself bactericidal. This mucus is continually moved upwards and ejected by the action of the ciliary processes of the bronchial mucous membrane. Removal of the secretion, together with engulfed organisms and other particles, is aided by the respiratory movements. Moreover, the epithelial lining has a free blood supply so that, at need, a plentiful supply of leucocytes will pass from the capillaries to the epithelium to aid the latter in its combat with infecting bacteria. The inspired air, before reaching the lungs, comes in contact with the mucous membrane of the nose and throat, and being deflected at the numerous folds and angles in these passages, is cleansed of dusty particles which adhere to the moist epithelium. The ring of lymphoid tissue in the upper end of the pharynx is an important element in the defence against infection. The sensitive reflex of the glottis prevents the entry of foreign bodies from the pharynx, and the cough reflex aids in the removal of material from the larger tubes.

Bronchitis results either from a failure of the defences of the respiratory tract as a result of their being overwhelmed by a virulent infection, or by depression of the resisting power as a result of exposure to cold, or as a consequence of some defect in the anatomical structures. In a few cases infection is carried to the bronchi by the blood stream.

ACUTE BRONCHITIS

Acute bronchitis, or catarrhal inflammation of the larger and medium sized bronchi, is not a serious disease except in infancy and old age.

Ætiology—Acute bronchitis often follows from "catching cold." The inflammatory process extends from the nasal fossæ down the pharynx and trachea to the bronchial mucous membrane. It is also a prominent feature in many influenzal epidemics; it follows the inhalation of irritant vapours and organic dust and occurs in association with other diseases especially measles, whooping cough and the enteric fevers.

Infecting organisms include pneumococci, streptococci, *M. catarrhalis* and *B. influenzae*.

Morbid Anatomy—The mucous lining of the bronchi is congested, œdematous and sometimes ulcerated. While on its surface there is a great excess of mucus mixed with more or less pus. Microscopically the goblet cells are seen to be distended while the walls of the tube are infiltrated with leucocytes.

Symptoms—At the onset there is a feeling of oppression and languor together often with myalgia. The temperature and respiration rate are only slightly raised. The cough is at first difficult and painful, the expectoration scanty and viscid. After a day or two the sputum becomes more plentiful and purulent and the cough easier with great relief to the patient. As a rule the symptoms subside after a week and recovery is more or less complete at the end of a fortnight. In the case of infants and of feeble elderly subjects there is a danger of the smaller tubes becoming blocked with secretion and of broncho pneumonia resulting.

Physical and Radiological Signs—The tongue is usually coated and the voice husky. As regards the chest signs are often surprisingly slight. In most cases a few high and low pitched rhonchi are heard accompanying inspiration scattered over both lungs and moist rales may be detected chiefly in the lower lobes. Radiologically active vascular congestion may be apparent.

Diagnosis—There is little difficulty in diagnosing acute bronchitis. It may however be only a feature heralding the onset of some more serious disease such as typhoid, measles or whooping cough.

Treatment—The patient should stay in bed and keep warm. A steam kettle relieves the sensation of rawness in the chest as also do inhalations from oil of pine (sibericæ) 3ss in \odot 1 of nearly boiling water. Dover's powder or syrup of codeine should be given at night and during the first few days a mixture containing 3 to 5 gr. of potassium iodide or 12 minims of vinum antimoniale may be used to loosen the expectoration. An alkaline expectorant should be given as soon as the cough is productive.

In children, relief is obtained by rubbing the chest with a stimulating liniment such as camphor. If there is much secretion, and expectoration does not keep pace with it, vomiting should be induced by administration of a tablespoonful of tincture of ipecacuanha.

Bronchiolitis—Bronchiolitis or capillary bronchitis is an acute inflammatory process involving the smallest air tubes. It is a dangerous complication of acute bronchitis, not uncommon in young children, it is relatively rare in adults, but was the cause of death in many of the cases of influenza in the pandemic of 1918.

Symptoms—As a rule the symptoms of inflammation of the larger tubes are present for several days before the bronchioles become affected. When the smallest tubes become involved they are quickly obstructed by secretion and swelling of the walls, and a profound change comes over the clinical picture. Dyspnoea and tachycardia become marked. The face takes on a peculiar lilac tinted lividity, the patient becomes exhausted, and mental disturbance is shown by delirium or coma.

Physical and Radiological Signs—On examination of the chest the intercostal spaces are seen to fall in during inspiration. Areas of unpaired resonance may indicate collapse of portions of the lungs. Râles are to be heard over the lungs, while widespread acute emphysema greatly reduces breath sounds. X ray appearances are very variable, in a mild case only a few fine scattered opacities of lobular collapse will be seen but in more serious examples of the disease the appearances more nearly resemble those of bronchopneumonia with multiple patchy ill defined shadows particularly involving the bases. In addition, the increase in chest size and translucency characteristic of emphysema will be found.

Prognosis—In acute cases the outlook is extremely grave but recovery is not uncommon in those of a less fulminating type. An occasional sequel is the development of a permanent dilatation or bronchiectasis.

Treatment—An abundant supply of fresh air is essential. The patient should be nursed as far as possible outdoors. Oxygen should be administered continuously by means of a tent, mask, or nasal catheters. Venesection may be beneficial, hypodermic injections of atropine are given at regular intervals in order to diminish the quantity of secretion and so relieve the obstruction in the bronchioles. Sulphonamides have yet to be proved to be of value. Therapy is otherwise that of bronchitis.

CHRONIC BRONCHITIS

Ætiology—Chronic bronchitis is a common affliction in those over forty, and it is occasionally encountered in the young. It occurs most frequently in cold damp climates among those who live in towns. At first they are affected only in the cold season but as time goes on the condition lasts longer and longer into the summer until ultimately it continues all the year round. It may follow several attacks of acute bronchitis and may be consequent on some structural defect of the lungs such as emphysema which diminishes their mobility, in turn producing stagnation of the bronchial secretion and infection of the bronchi themselves.

Other conditions which favour the development of chronic bronchitis are spinal curvature fibrosis following unresolved pneumonia empyema and asthma. In the absence of any of the above, search should be made for some focus of infection from which organisms may be entering the respiratory passages. Such foci may be present in oral sepsis disease in the nasal fossæ or accessory sinuses.

Morbid Anatomy—The lungs are emphysematous the mucous lining of the bronchi may be thick and granular, but in some cases it is atrophied. Bronchiectasis may coexist.

Symptoms—A major complaint is of shortness of breath on exertion. This is due partly to the associated emphysema and partly to the presence of excessive secretion in the tubes. This secretion becomes churned into a foam by the air passing through the bronchi, and interferes with the entry of the inspired air into the air sacs. The capacity for work and exercise is greatly diminished by the restricted intake of oxygen as well as by the absorption of toxins from the infected secretions. The cough is apt to be most troublesome during the night disturbing sleep. The lack of sleep together with dyspnoea and toxæmia sometimes lead to emaciation. The sputum consists chiefly of translucent gelatinous mucus which in town dwellers is stippled with black carbon particles. During exacerbations of the disease, admixture of pus renders the sputum yellow or green, and streaks of blood may appear as a result of oozing from the congested or ulcerated mucosa.

Asthma frequently complicates the disease. Occasionally in cases of long standing the presence of extensive emphysema leads to a consecutive rise of the pulmonary arterial pressure, and eventually to hypertrophy of the right ventricle. In such cases terminal congestive heart failure is sometimes seen.

Physical and Radiological Signs—The signs are usually

casts are sometimes expectorated after paracentesis for pleural effusion, or in association with pneumonia, pulmonary tuberculosis, or mucous colitis

BRONCHIECTASIS

The ætiology of bronchiectasis is uncertain. Dilatation of the bronchi may occur in the main trunks, in smaller branches, and even the bronchioles may be involved. In extent it may be widespread throughout the lungs, or limited to a few tubes in one lobe. Most commonly the lower lobes are involved. Dilatation of the larger trunks tends to be cylindrical or fusiform, while smaller bronchi and bronchioles which have little muscle and no cartilage in their walls dilate to form sacculi.

Complete bronchial obstruction gives rise to massive collapse of the lung which in turn causes a considerable fall in the intrapleural pressure, since the volume of the contents of a semi-rigid structure has been diminished. The decrease in volume is partly made good by movement inwards of the thoracic parietes, by displacement of the mediastinum toward the atelectatic lung, by compensatory emphysema of the residual lung and by dilatation of the bronchi within the atelectatic area. Clinically, furthermore the association of bronchiectasis with antecedent pulmonary inflammation, such as the pneumonias, particularly broncho pneumonia, lung abscess, and tuberculosis, is well recognised.

Basal bronchiectasis occurs more commonly in the left than in the right lung. This is probably due to the anatomical relations of the left main bronchus, which render it more susceptible to compression when, for example, tuberculous mediastinal lymphadenitis develops.

Finally, congenital cystic disease of the bronchi, which is probably less rare than has hitherto been believed, has many characteristics (*vide p. 607*) so similar to those of acquired bronchiectasis as to suggest that a developmental abnormality may play a part in the ætiology of the latter.

Morbid Anatomy—When the affected lung is incised and the cut surface inspected, the dilated tubes are seen with their congested mucosa projecting. Microscopical examination of the bronchiectatic cavities shows their epithelium to be degenerate and devoid of ciliary processes and in some cases to be replaced by granulations and fibrous tissue. In the area affected the lung may be atelectatic, and often evidence of chronic pneumonia is shown together with a more or less

extensive fibrosis. Emphysema in the peripheral and uninvolved areas of lung is always present.

Symptoms—It is probable that many patients in whom bronchial dilatation is present continue without symptoms for long periods of time. Not infrequently the only symptom is recurrent, often severe, hæmoptysis. As a rule, however, infection within the dilated tubes dominates the clinical picture, and then periodic attacks of violent cough productive of large quantities of purulent sputum result. The most severe paroxysm as a rule occurs with change in posture, for example, when the patient awakes in the morning, and such an attack often culminates in vomiting. There may be no cough during the greater part of the day, so that the patient suffers little discomfort, but intercurrent infections are liable to cause exacerbation of symptoms with pleurisy, pyrexia, foetid sputum, and anorexia. In unilateral bronchiectasis the patient lies on the affected side for his sleep will not be disturbed by cough as long as the secretions remain in the dilated and insensitive tubes. He may live many years. Death may result from toxæmia, broncho pneumonia, cerebral abscess, or amyloid disease.

Physical and Radiological Signs—If the disease is minor in degree and remote from the surface, there may be no abnormal signs and diagnosis must be based on the symptoms. Where there are saccular dilations near the chest wall clear signs of cavitation with amphoric breathing and coarse râles may be obtained. Associated atelectasis and fibrosis result in mediastinal displacement towards the affected side, impaired movement and percussion note, and a diminished air entry, which may be bronchial in type. The fingers and toes may be clubbed, and the nails curved and thick. Sometimes there is hypertrophy of the phalanges, wrists, and ankles—"hyper trophic pulmonary osteo-arthritis."

Radiologically lobar or lobular atelectasis may be shown, and not infrequently the outline of the hollow dilated bronchi may be seen. On other occasions patchy consolidation may be the only demonstrable abnormality, while often bronchiectasis is not revealed by X ray examination unless special technique be used. For this purpose the cricothyroid membrane is punctured with a short stout needle and 15 to 30 c.c. of warm lipiodol is injected into the trachea, after the injection of 0.5 c.c. of 5 per cent cocaine, sensitivity to which must previously have been excluded. The patient is tipped in position so that the fluid runs into the bronchi which are required to be rendered opaque to X rays (*vide* Plate 25). An



PLATE 25 —Bronchiectatic Cavities in the Upper Lobe filled with Lipiodol



PLATE 26 —Bronchial Carcinoma Lipiodol has been injected into the bronchial tree, and shows the site of the obstruction (marked by the arrow) which has produced atelectasis of the right middle and lower lobes

[To face page 606]

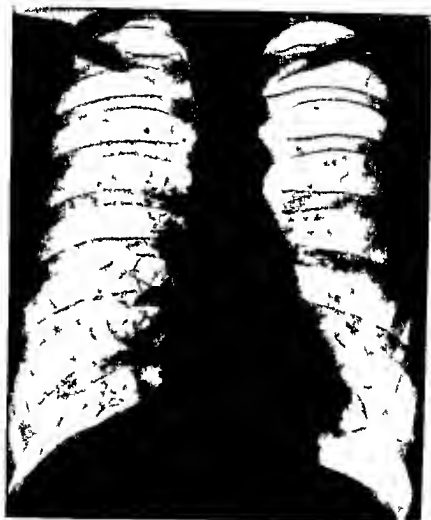


PLATE 9 —Congenital Cystic Disease of the Bronchi

alternative and often successful method is to run the lipiodol through a special cannula over the back of the tongue, after the pharynx and larynx have been cocaineised. Tomography is also of value in establishing the site and extent of the disease.

Treatment—Early efficient treatment of such disorders as massive collapse and broncho pneumonia will reduce the incidence of bronchiectasis. Once sepsis has become established the deformity of the tubes is permanent and cannot be remedied, so that treatment is designed to keep the cavities as clean as possible. The secretions must be emptied out several times a day by postural drainage, the patient with basal disease lying on an inclined plane head downwards and coughing. Continuous postural drainage is greatly facilitated by the use of the Nelson tilting bed. Concurrently breathing exercises should be employed. Antiseptic inhalations are beneficial, creosote or turpentine being used on a Burney Yeo inhaler. If the severity of the symptoms justifies radical treatment, the method of choice is excision of the affected lobe or lobes. This must only be undertaken after complete bronchography has demonstrated that the diseased bronchi are limited strictly to the area to be removed at lobectomy or pneumonectomy. This form of therapy should rarely be attempted in patients over the age of forty five, or in those in whom cardiovascular or other disease coexists. In a very few selected cases amelioration of symptoms may follow collapse therapy by thoracoplasty, artificial pneumothorax, or phrenic avulsion.

CONGENITAL CYSTIC DISEASE OF THE BRONCHI

In the last decade an increased interest in the problem and the widespread use of radiology in the investigation of diseases of the chest have made it seem likely that cystic disease of the bronchi of congenital origin exists. Cystic dilatation of bronchi, however, can undoubtedly be acquired. Isolated cases in which the disorder has occurred in the foetus are on record, and it is thought that arrest or abnormal development of the lung buds at an early stage may account for their formation. Pathological investigation has shown that the epithelial lining of these cysts tends to be uniform and constant in type, and furthermore that the supporting tissues, e.g., cartilage, muscle, vessels, and glands, are most erratically distributed in the cyst wall. In these respects the histology of the disease differs from that of bronchiectasis or lung abscess.

In the existing state of our knowledge it is convenient to adopt a clinical classification of this disorder such as the following —

- 1 Cysts not communicating with bronchi
- 2 Cysts communicating with bronchi
 - (a) Simple unilocular cysts
 - (b) Multiple cysts (soap bubble and berry types)

Congenital bronchial cysts which do not communicate with the bronchial tree are very rare, they contain fluid and as far as is known produce no symptoms. In one case seen by the writer about sixteen such cysts varying in size from a pea to a golf ball were disclosed following the routine radiological examination of a patient aged forty. He had had no serious pulmonary disease and remained well during a five year period of observation in which the radiological appearances persisted unchanged. Occasionally such a cyst may rupture into a bronchus, thereby discharging its contents and subsequently behave as those of the second category.

Cysts communicating with bronchi contain air, and are characterised radiologically by very clearly defined thin limiting walls. As a rule they give rise to few distinctive signs or symptoms unless and until secondary infection supervenes. Occasionally, however, particularly in infants and children, increasing inflation of a solitary cyst by check valve action of the communicating bronchus may occur and lead to gross increase in size of the cyst and all the consequences of a tension pneumothorax. Radiologically such cases may usually be differentiated from the latter by the absence of the collapsed lung at the hilum and the presence of traces of pulmonary tissue at the periphery of the hemithorax. Furthermore cysts communicating with bronchi are particularly liable to give rise to hæmoptysis and when this happens the unexpecterated blood within the cyst sometimes clots. Under such circumstances a characteristic radiological picture is given for with retraction of the clot from the cyst wall the appearance of a stone loose within its setting is shown.

We do not know what is the proportion of cases of cystic disease of the lungs which remain uninfected throughout life and since it is the advent of infection within the cyst or cysts which as a rule brings these cases to our notice, it is not improbable that at present we overestimate the probability of infection. In our own experience three cases each over the age of fifty, have been encountered by chance in which there were and had been no symptoms associated with the disorder.

On the other hand, septic infection when it does occur is commonly severe and often fatal. Attacks of bronchitis frequently accompanied by bronchial spasm may precede a fulminating septic pneumonia by months or even years. Large infected single cysts have the signs of and behave as would a lung abscess, while multiple cysts quickly give rise to the clinical syndrome of advanced bronchiectasis. When infection is sufficiently prolonged it is not unusual for acquired atelectasis and bronchiectasis to complicate the disorder. In such cases the clinical diagnosis of congenital cystic disease cannot be made with certainty.

In uninfected cases difficulty in diagnosis from localised pneumothorax and emphysematous bullæ may be encountered. The history of the case, the age of the patient and the site, appearance and shape of the lesion will be of assistance, certainty of diagnosis however, may only be obtained by histological examination after lobectomy.

Infected cysts have to be distinguished from empyema (including interlobar empyema), lung abscess and saccular bronchiectasis. The failure to respond to adequate drainage will suggest a cyst rather than an empyema, while a lung abscess often shows clinical and radiological evidence of surrounding pneumonitis. As has been said it may not be possible to distinguish saccular bronchiectasis from cystic disease. The distinction, however, is of academic interest rather than of therapeutic importance.

Radical treatment of symptomless congenital cysts of the lung is rarely justified. Close observation and prophylactic measures designed to prevent respiratory infections are, however, necessary. The exceptions to this will as a rule be found among children in whom the chance of infection is relatively great, and whose resistance to the hazards of operation is considerable. Therapy in those cases with lesions productive of symptoms should, where possible, consist of radical removal by lobectomy or pneumonectomy, and adequate bronchography must precede the operation, for the disease is commonly bilateral or complicated by acquired bronchiectasis in the remaining pulmonary tissue. In acutely infected single cysts preliminary drainage may be of value.

In those cases in which suppuration has occurred and in which for any reason operative removal of the diseased area cannot be undertaken, postural drainage, expectorants, and creosote may alleviate symptoms.

DISEASES OF THE LUNGS

EFFECTS OF DISTURBANCE OF THE CIRCULATION

Congestion—Active congestion accompanies all inflammatory diseases of the lungs, and is seen most strikingly in the first stage of lobar pneumonia.

Passive congestion occurs when, following a rise in pressure within the pulmonary veins, there results a slowing of the circulation through the lungs. Such congestion may happen rapidly in the left ventricular failure associated with coronary thrombosis, while it is a chronic process in cases of mitral stenosis. It is, moreover, one of the earliest indications of heart failure, whatever the type of heart disease. The more dependent portions of the lungs, usually the bases, are the first and the most affected. Pulmonary oedema may develop.

Symptoms referable to the condition are dyspnoea including cardiac asthma, cough, and expectoration. The first of these is, at any rate in part, due to the diminished elasticity of the lungs caused by the increase in pressure in the pulmonary circulation. Hæmoptysis, usually minor in degree, often occurs. The physical signs, apart from those of the underlying cardiac abnormality, include a diminished chest expansion and air entry, together with an impaired percussion note and râles at the bases.

The post mortem appearances in chronic venous congestion are described on p. 550.

Oedema of the Lungs—Oedema of the lungs may result from infection, from the inhalation of irritant gases, but is commonly secondary to disease of the heart, aorta, or kidneys, occasionally it develops after aspiration of a pleural effusion. The symptoms may come on suddenly, the patient is seized with extreme dyspnoea and pain in the chest and expectorates large quantities of serous or blood stained froth. He may lose consciousness and die or the symptoms may subside after an hour or two and recovery take place, some patients have survived repeated attacks. Treatment is essentially that of left ventricular failure, and the most effective measures consist of rest, venesection, and the injection of morphia gr $\frac{1}{4}$ and atropine gr $\frac{1}{16}$, followed by efficient oxygen administration.

Embolism and Infarction.—*Vide* p. 587.

EMPHYSEMA

In this condition the air sacs are dilated and their walls atrophied, while frequently the rupture of the walls of many

alveoli results in the formation of bullæ. A number of varieties of the condition occur, the chief forms being known respectively as hypertrophic, atrophic, compensatory, acute vesicular, and acute interstitial.

Hypertrophic Emphysema—*Ætiology*—This is uncertain. Hypertrophic emphysema occurs frequently in some families, and may be associated with an inherent weakness of the elastic tissues of the lungs. Freund, on the other hand, has suggested that premature ossification of the costal cartilages, with immobility of the thoracic wall, is the primary change. The frequent occurrence of emphysema in association with bronchitis and asthma, however, would make it seem probable that long continued expiratory obstruction is the important causal factor. Localised emphysema occurs when a bronchus is partially obstructed by, for example, a growth or foreign body.

Morbid Anatomy—The thorax is enlarged chiefly in its anteroposterior diameter and the intercostal spaces are wide. On opening the chest, the lungs fail to collapse, they are voluminous and hide the pericardium from view, they are pale in colour, and projecting bullæ may be seen, especially near the apices and anterior margins. Microscopic examination shows large, thin walled alveoli, which in many places form extensive irregular chambers owing to disappearance of the inter alveolar septa. These septa support the capillaries concerned in the gaseous exchanges of the blood, so that their disappearance causes a great diminution in the capillary bed of the pulmonary circulation. Rarely the right ventricle may show varying grades of hypertrophy and dilatation.

Symptoms—The characteristic symptom of emphysema is dyspnoea. In the earlier stages this is only noticed on exertion, but as the condition develops the shortness of breath occurs with less provocation until finally it is continuous even at rest, and is accompanied by cyanosis and circulatory failure. The dyspnoea partly results from the mechanical disadvantage of the increased residual air characteristic of the condition, and partly from the decreased elasticity of the lungs. The symptoms are aggravated by the accompanying bronchitis to which all emphysematous patients are susceptible.

Physical and Radiological Signs—The condition is revealed by inspection of the thorax, which in characteristic cases is barrel shaped. It is deep from back to front the ribs are horizontal and kept in the position of inspiration, the subcostal angle is widened, and the normal 3 to 4 in expansion is diminished to 1½ in or less. The shoulders are raised, the spine is kyphotic, and there is no visible impulse in the precordium.

The percussion note is hyper resonant and dullness over the heart and liver is obliterated. The breath sounds are feeble and the expiratory murmur is prolonged. X-ray shows an enlarged thorax, horizontal widely spaced ribs, a low poorly moving diaphragm and relatively more translucent lung fields. The heart is sometimes elongated and thin. In advanced cases pulmonary vascular engorgement with or without right ventricular hypertrophy may be seen. Large bullæ, crossed by fine strands of pulmonary tissue are sometimes present.

Treatment—The changes in the lungs are degenerative and irremediable. The chest wall may be rendered more mobile by suitable exercises but the most profitable methods of treatment are those designed to cure or prevent bronchitis. Equable climatic conditions are of the greatest importance, and if possible the patient should not winter in a smoky city or in a locality where sudden changes of temperature or cold winds are prevalent.

Atrophic Emphysema—This is a senile change and accompanies other stigmata of degeneration. The alveolar walls become atrophic and the septa give way, but the lungs are small and retracted and the ribs oblique.

Compensatory Emphysema—This is a local distension of the alveoli, and is the result of shrinkage of other regions of the lungs from collapse or fibrosis. The intra thoracic pressure being negative, when the contents of the chest become diminished by disease, the nearest healthy and elastic portions of the lungs become distended to occupy the vacant space. At first the alveolar walls are simply stretched, but in course of time they become atrophied and true emphysema develops.

Acute Vesicular Emphysema—This condition occurs as a result of sudden severe over distension of the alveoli, such as may be associated with excessive cough and muscular strain. It is uncommon but is found, for example, in cases of asphyxia, poisoning by irritant gases, whooping cough, and acute laryngitis. Symptoms and signs are usually masked by those of the causal condition but are essentially those given under hypertrophic emphysema.

Acute Interstitial Emphysema—This is a variety of surgical emphysema in which air is driven through a rupture in the alveolar wall into the pulmonary interstitial tissues. It may occur in whooping cough as a result of trauma and during sudden muscular strain. If sufficiently extensive it will involve the mediastinum and even spread to the neck and face. As a rule the air is absorbed spontaneously in a few days though death may occur quickly. Clinically the patient

is dyspnoeic and may be cyanosed, and often complains of tightness and pain in the chest. Surgical emphysema may be palpable in the neck, crackling noises may be heard widely over the chest, and X ray may show the presence of air in the soft tissues. Treatment consists of absolute rest, abolition of the cough reflex with morphia, and the administration of oxygen.

PULMONARY COLLAPSE

Collapse of the lung may be partial or complete. The former occurs when the diaphragm is elevated for any cause or when for example air or fluid of any kind accumulates in the pleural cavity. Both the air entry and the blood and lymph flow in the involved lung are diminished in proportion to the extent of the collapse while a compensatory increase in ventilation and circulation takes place in the other lung. The diminution in air entry is reflected in the physical signs which are otherwise those of the causal condition. Radiological examination reveals the cause and indicates the extent of the collapse. As a rule re expansion of the lung from partial collapse immediately or rapidly follows the removal of the productive lesion and there are then no pulmonary sequelae. Complete collapse of lung often called pulmonary atelectasis may persist because the lung does not expand at birth or may develop following absorption of air by the circulating blood if a bronchus or bronchiole is completely obstructed. The causes of such an obstruction have been discussed (*vide p. 509*).

Acquired pulmonary atelectasis is a common condition. It plays a fundamental part in the pathology of many pulmonary inflammations and injuries is frequently associated with any kind of intrathoracic tumour, and may supervene upon partial pulmonary collapse from kinking or defective drainage of a bronchus. The extent of the lesion is determined by the size and number of bronchi or bronchioles obstructed thus a lobe or the whole lung becomes atelectatic respectively if the lobar or main bronchus is occluded (the so called massive collapse) while scattered lobular atelectasis follows multiple bronchiolar obstruction. The lower lobes are most commonly affected, and the left lower lobe more commonly than the right.

Complete collapse of an area of lung diminishes the volume of the thoracic contents. Partial compensation occurs by displacement of the thoracic parities and mediastinum toward the collapsed area, by emphysema of the remaining and particularly the adjacent pulmonary tissue, and by dilatation of

bronchi and blood vessels within the atelectatic lung. Since of these structures some are semi rigid some relatively elastic, the change occurs at the expense of the development of an increase of tension locally—a measure of which may be obtained if the intrapleural pressure is recorded when it will be found that this pressure is more removed from atmospheric (more negative) than is the case over normal lung. Important changes follow. Vascular dilatation within the completely collapsed lung has as a result the return of venous blood to the left side of the heart and therefore a fall in the oxygen saturation of the arterial blood. Further impairment of circulatory function is due to the distortion of the great veins arising from mediastinal displacement and this effect is enhanced as may be shown at radio copy with each inspiration.

Emphysema of adjacent lung may become permanent and similarly the stretched bronchi may lose their elasticity beyond recovery particularly if infection of their muscle coats supervenes. Since with bronchial obstruction the drainage of the sputum ceases infection in these bronchi and in the collapsed lung as a rule quickly follows. Bronchiectasis and pulmonary suppuration with lung abscess formation may therefore develop. Pulmonary atelectasis may persist even if the cause is removed.

Symptoms—Congenital pulmonary atelectasis causes pallid asphyxia. The acquired form if extensive gives rise to cough, dyspnoea, cyanosis and pleuritic pain from the onset of collapse while to these are added the consequences of infection if and when that occurs.

Physical and Radiological Signs—Diminution in size and limitation of the movement of the chest wall on the affected side may be seen and felt as may displacement of the heart and trachea. Over the atelectatic lung the percussion note is impaired while adjacent areas will be hyperresonant. Atelectatic lung conducts sound at least as well as does consolidated lung when therefore it is adjacent to a bronchus through which air is passing auscultation will reveal bronchial breathing, bronchophony and whispering pectoriloquy though when the atelectatic area (e.g. a lower lobe) is distant from such a bronchus breath sounds and vocal resonance may be diminished or absent.

Radiologically atelectatic lung is homogeneously opaque. The site and size of the opacity will depend upon the area of lung involved and there will in addition be associated emphysema of adjacent lung and mediastinal displacement toward the affected area. Multilobular atelectasis can only be differentiated radiologically from broncho pneumonia by this displacement.

Treatment—The treatment of partial pulmonary collapse is that of the cause. Pulmonary atelectasis arising as a result of the inhalation of foreign bodies, or by viscid sputum, or blood clot obstructing a major bronchus is a medical emergency demanding bronchoscopy at which the obstruction can frequently be removed. This procedure may also permit accurate diagnosis in those cases in which the cause is not obvious by routine investigation. In multilobular atelectasis and in cases where bronchoscopy fails to relieve the atelectasis and where no gross cause such as neoplastic disease is present, postural drainage, an expectorant containing potassium iodide, inhalations of 5 per cent CO_2 in oxygen, and breathing exercises may be advisable. Some of the serious consequences of extensive temporary atelectasis may be prevented by the induction and maintenance of a small pneumothorax until bronchial obstruction is relieved. The treatment of intrathoracic tumours and of the bronchiectasis and other consequences arising from pulmonary atelectasis is set forth elsewhere.

THE PNEUMONIAS

Pneumonia is essentially an inflammation of the substance of the lung, with the production of exudate in the alveoli. Acute and chronic forms may be considered in two separate groups: lobar or croupous pneumonia, and lobular or broncho pneumonia. Lobar pneumonia is a specific infective disease with a characteristic clinical course due to a particular organism.

Broncho pneumonia is in most instances a secondary condition; its course is indefinite and bacteriology variable, and it is possible to distinguish several varieties which have fairly well defined clinical and pathological characteristics.

LOBAR PNEUMONIA

Bacteriology.—The causative organism is the *Streptococcus pneumoniae* or *Pneumococcus*. This is a capsulated lanceolate gram positive coccus growing in pairs or short chains. Dochez and others have shown that the pneumococci may be divided by means of agglutination and precipitation tests into various types. Three of these types occur with considerable frequency in adult pneumonia and are sometimes termed the "fixed" types. They are designated by the Roman numerals I, II, and III.

In addition to these types there occur nearly thirty other strains which, while capable of stimulating the formation of

specific antibodies, do not occur individually sufficiently frequently to justify their separation as distinct "types." These are classed together as "Group IV" and are frequently present in the normal throat.

This classification has considerable practical importance in regard both to the prognosis and specific therapy of pneumococcal infections as a whole, and particularly in regard to lobar pneumonia. The following table shows (1) the relative frequency of the various types of pneumococci in lobar pneumonia in a series of cases investigated by Glynn, Digby, and Jones in England, and (2) the case fatality per cent as recorded by Cecil.

	Type I	Type II	Type III	Group IV
	Per Cent	Per Cent	Per Cent	Per Cent
Relative frequency	45.8	24.0	2.1	28.1
Case mortality	22.0	40.3	40.0	24.0

The relative frequency and the case fatality of the individual types varies considerably from year to year, and in different localities, but generally speaking Type III appears to be the least common and most fatal infection, while Type I is the most frequent and has the lowest mortality.

It must be pointed out, however, that the pneumonic infections of very young children are very seldom caused by "fixed" types, and that Group IV infections are in such patients as commonly fatal as Types I, II, and III. At times lobar pneumonia has been known to occur in almost epidemic form and it may be found that the majority of cases in such an epidemic belong to a homogeneous type which does not belong to Types I, II, or III.

Serological specificity is of therapeutic importance. At the present time (1942) no efficient serum has been prepared against Type III while Group IV, consisting as it does of a heterogeneous group of organisms, is not benefited by any polyvalent serum. Highly concentrated sera are obtainable containing Types I and II antibodies mixed together, or mono specific containing either Type I or II alone. As the dosage to be effective must be large, it is preferable to use mono specific sera, both for economical reasons and in order to avoid administering useless foreign protein. Rabbit serum is now available and causes fewer allergic complications than does horse serum.

It is of extreme importance to determine the type of infection as early as possible, for it has been amply shown that the serum treatment should be begun as soon as possible if the best results are to be obtained. A rapid method of typing has been devised which supersedes almost entirely the mouse inoculation method. This is based on the fact that the type specificity is related to the chemical constitution of the capsules of the cocci, which on treatment with homologous sera show swelling and altered staining. By this means pneumococci may be directly typed within an hour from sputum, blood, pus, or lung juice.

Although it seems probable that chemotherapy is a more effective single measure in the treatment of lobar pneumonia than immunotherapy, Fleming has shown that the combination of both is more effective than either used alone.

Ætiology—Lobar pneumonia occurs most commonly in temperate climates, and it accounts for a greater number of deaths than any other acute disease in the United Kingdom. Although most cases are sporadic, widespread epidemics occur from time to time. It is common at the two extremes of life, and relatively rare between the ages of six and fifteen years. In children complications such as empyema are frequent, but the mortality is low, after the thirtieth year mortality rises with each decade. Above the age of sixty there are relatively few recoveries, and indeed it kills so quickly and mercifully that it has been called "the old man's friend." In children the sexes are attacked equally, but in adults 70 per cent of cases occur in males. One attack does not confer immunity, on the contrary, one or more recurrences often follow, and Rush has recorded a case in which one individual had pneumonia twenty eight times. Successive attacks are usually mild. The negro races are specially susceptible.

Pneumonia sometimes follows chest injuries and the inhalation of irritant gases, but the commonest ætiological factors are those which impair the defensive mechanism against infections, such as old age and chronic debilitating diseases. Instances of the latter are diabetes, nephritis, portal cirrhosis, and chronic alcoholism, moreover it is said that one sixth of all insane persons die of pneumonia (G. W. Norris). Of acute illnesses influenza is the one most often complicated by pneumococcal pneumonia though it usually takes the lobular form. When healthy young adults are attacked it may be a result of exposure to cold, or exhaustion following violent physical exertion. Lobar pneumonia occasionally follows operations, though post operative complications such as

broncho pneumonia massive collapse or infarction are more common

Pathology and Morbid Anatomy—The disease commences as a septicæmia which may continue for several days before any local involvement of the lung becomes apparent. Pneumococci are thought to enter the blood stream from the nasopharynx. Blood culture at this stage will in severe cases produce a growth of the pneumococcus. Later the specific organism can be recovered from the sputum. The inflammatory reaction in the lungs passes through four stages and pneumococci can be demonstrated to be present in the affected area during the earlier of these. The first is the stage of *congestion* the affected portion of the lung is dark red and heavy though it still contains sufficient air to float in water. The capillaries are dilated and the alveoli contain a little fluid resembling blood. The second stage is that of *red hepatization* the lung resembling liver in appearance and consistency. The affected lobe is swollen and of a reddish brown colour the pleura is dull and covered with a film of yellow fibrin. The air sacs are filled with solid fibrinous clot in which are entangled many red cells and some leucocytes. The lung tissue is friable and so heavy that it sinks when placed in water. The third stage is that of *grey hepatization* the consistency is similar to that of the second stage but the colour is changed to a reddish grey. The size of the affected lobe is further increased the pleura is covered with thick yellow exudate and an ounce or two of turbid fluid may be seen in the pleural cavity. Microscopically the clot in the air sacs is found to be crowded with leucocytes. The red cells are degenerate and the leucocytes contain numerous fat droplets. In the stage of *resolution* the appearance resembles that of grey hepatization but has a remarkable translucency. Inflammatory blood borne lesions may be found in other organs. pericarditis often accompanies left sided pneumonia and malignant endocarditis arthritis and meningitis are sometimes seen colitis also occurs.

The right lung is attacked more often than the left and the lower lobe is usually the one first affected. The inflammation may spread to a contiguous lobe or to a lobe of the opposite lung.

Symptoms—The onset is sudden often with a rigor and the temperature rises to 103° F or over on the first day. In children the onset is commonly indicated by vomiting and sometimes by meningism. The pyrexia is continuous and lasts from five to nine days then falls suddenly to normal in a few hours, at the same time pulse and respiration rates

fall, and the whole aspect of the patient changes from one of great distress to one of comfort. This abrupt termination is known as the *crisis*. In more than one third of the cases the symptoms subside gradually and the temperature takes several days to reach the normal level—termination by *lysis*. At the onset the patient complains of an agonising pain in the side, due to accompanying pleurisy. If diaphragmatic pleurisy is present pain may be referred to the abdomen or to the tip of the shoulder. There is a dry, painful cough and tenacious mucoid sputum. The patient lies on the affected side, his face is flushed, often on one cheek only. Labial herpes often appears about the third day, the tongue is coated and the skin dry. Breathing is rapid and jerky with an expiratory grunt, and the *alæ nasi* dilate with each breath. Although there is tachycardia the respiration rate is usually proportionately more increased so that the pulse respiration ratio falls to 3 : 1 or even 2 : 1. Sometimes hæmolytic jaundice develops. The sputum is usually mucoid at first, after twenty-four hours it becomes blood-stained, and later the bright red changes to a pale rust colour. Nocturnal delirium is apt to occur especially when the upper lobe is affected, and is frequent in alcoholics. Constipation, anorexia and loss of weight are common.

Physical and Radiological Signs—On inspection of the chest the affected side usually moves less than the other, but the difference may not be great. In the stage of engorgement the only abnormal sign may be slight impairment of resonance, but fine rales are often audible, especially after cough. In the stages of red and grey hepatisation there is dullness to percussion over an area roughly corresponding with a lobe of the lung and auscultation reveals tubular breathing which becomes extremely striking when the consolidation is complete. A pleural rub is commonly audible. Together with this alteration of the breath sounds bronchophony and pectoriloquy are heard. These physical signs do not alter at the time of the *crisis*, but later, as resolution of the inflammatory exudate takes place, coarse rales (reduced crepitations) appear over the affected area and the signs of consolidation become patchy and disappear.

Typically, X-ray shows a more or less uniform opacity corresponding in position to the affected lobe. With resolution this area becomes increasingly mottled by re-aerated lung.

Examination of the blood shows a great increase in the number of leucocytes which may number from 20,000 to 60,000 per cubic millimetre. This increase, which is mainly made up

of polymorphonuclear cells is found in the earliest stage of the disease and subsides with the crisis. The white count is of considerable value in estimating the prognosis—a white count of less than 10 000 indicates a very poor chance of recovery.

The urine is scanty and highly coloured; there is a retention of chlorides in the body and a diminution of these salts in the urine until after the crisis. Albuminuria is constant while hyaline and granular casts are commonly found. These abnormalities are usually due to toxic nephrosis which is often minor in degree.

Complications—Lobar pneumonia is often free from complications but the following occur—

1 *Pleurisy* occurs regularly and quite often (particularly if chemotherapy has been employed) is followed by effusion. Empyema is not infrequent (*vide p. 655*).

2 *Pericarditis*—This does not differ from other forms of acute pericarditis as regards signs and symptoms. The exudate is thick and buttery and of a yellow or slightly green colour. This complication is most often seen in left-sided pneumonia. Surgical drainage may be advisable as in empyema.

3 *Endocarditis*—This rare complication which may cause a second rigor is found occasionally at autopsy and affects particularly the aortic valve. It is of pathological rather than clinical importance.

4 *Heart failure*—Congestive heart failure complicates the disease sometimes in adults and in those who already have cardiac disease.

5 *Meningitis*—Pneumococcal meningitis usually occurs without involvement of the lungs. It can be distinguished from other forms of acute meningitis only by bacteriological examination of the cerebrospinal fluid. It is often fatal. It must be distinguished from the meningism sometimes occurring in children in the septicæmic stage of pneumonia in which there may be neck rigidity and Kernig's sign but the cerebrospinal fluid is normal.

6 *Peritonitis*—*vide p. 483*

7 *Otitis Media*—This may be a complication of pneumonia or may arise independently. The treatment is surgical. When bilateral mastoid disease occurs the condition is almost invariably fatal.

8 *Arthritis*—The pneumococcus occasionally produces an acute suppurative arthritis involving one of the larger joints. Aspiration of the pus should be tried before having recourse to open operation.

Cohitis, nephritis, phlebitis with venous thrombosis, parotitis, peripheral neuritis, and hæmolytic jaundice may occur. Very rarely the lung tissue may break down to form an abscess, or extensive necrosis give rise to gangrene. Occasionally the exudate in the alveoli fails to liquefy, resolution does not take place, and there is an invasion of connective tissue cells which produce a network of fibrous tissue—unresolved pneumonia. Minor degrees of this organisation, resulting in fibrosis, are quite common. Bronchial obstruction by debris during resolution may lead to atelectasis of the area of lung concerned. Numerous cases are met with in which a lobar pneumonia is followed after an interval by recurring attacks of bronchitis or by spasmodic asthma. A proportion of such cases are associated with a secondary bronchiectasis.

Prognosis—In children death rarely results from an uncomplicated lobar pneumonia. In adults as has already been pointed out, the prognosis becomes increasingly grave after the fortieth year, and in the aged the disease is almost uniformly fatal. A robust physique has little influence on the course of the disease but, on the other hand, the temperament of the patient is of great importance. Optimism and a determination to survive are of great assistance, whereas alarm and despondency defeat all efforts at treatment. Other unfavourable features are alcoholism and chronic diseases, such as diabetes or nephritis.

Though it is always difficult to forecast the course of any individual case, there are, however, certain unfavourable indications. Among these are a very high temperature, or, on the other hand, a practically apyrexial course, such as occurs in feeble and elderly subjects, severe toxæmia with delirium or cyanosis, especially when appearing early, involvement of several lobes in one or both lungs. In addition, a positive blood culture indicates massive infection, while a low leucocyte count implies a failure of protective reaction.

Diagnosis—Difficulty sometimes arises in distinguishing lobar pneumonia from pleural effusion, atelectasis, pulmonary infarction, broncho pneumonia, acute tuberculous pneumonia, and acute septic peritonitis.

In pleural effusion the distinguishing features are the shape of the area of impaired resonance, the obliteration of tactile vocal fremitus and the displacement of the heart and trachea away from the affected side of the chest, an exploratory puncture of the pleura will settle the question. In massive collapse or atelectasis the diagnostic sign is displacement of the heart and trachea *towards* the dull area in the lung. The

radiological appearances in pleural effusion and massive collapse are quite characteristic (*vide* pp 614 and 646 respectively). Infarction is met with most frequently a week or two after a surgical operation the onset is abrupt and painful and is followed in a few hours by expectoration of frankly blood stained material quite different from the rusty sputum which appears some days after the onset of a lobar pneumonia. Broncho pneumonia is nearly always bilateral shows from the first patchy mottled shadows on X ray examination and except in its primary form is characterised by a very different temperature range and clinical aspect from lobar pneumonia. Acute tuberculous pneumonia may at first be indistinguishable from the pneumococcal form but its long duration will give rise to suspicion and a bacteriological examination of the sputum will reveal its true nature. Acute pneumonia of one of the lower lobes with diaphragmatic pleurisy may give rise to severe abdominal pain with vomiting and constipation and present a clinical picture closely resembling that of appendix abscess or other acute peritoneal inflammation. Many such patients have been subjected to an unnecessary laparotomy with dire results. The increased respiration rate is suggestive of pneumonia while a careful clinical and X ray examination of the chest will usually prevent this error.

Treatment—Important measures are to ensure abundant fresh air and complete rest. The patient is propped up in a comfortable position in bed and must be disturbed as little as possible. Efficient nursing is essential and both day and night nurses are necessities.

Chemotherapy has vastly improved the outlook in all cases of lobar pneumonia. Sulfapyridine or sulphathiazole may be given in combination with the immunotherapy listed below. For an adult either of these drugs may be given by mouth as follows: 2 grm every four hours for twenty four hours followed by 1 grm six hourly until there has been no pyrexia for forty eight hours. Details regarding the administration of sulphonamide drugs are given on p 70. In infants and young children 0.2 grm per kilogram body weight daily of sulfapyridine in suitably divided doses is satisfactory.

When laboratory facilities admit of the infecting pneumococcus being typed the appropriate antiserum should be injected if it happens to be Type I or Type II. In the absence of laboratory facilities a concentrated polyvalent serum may be administered. The serum should be given at the earliest possible stage of the disease, for an adult the preliminary dose should be 5 c.c. and several doses totalling 70 c.c. should

be injected within twenty four hours. It is given intravenously, and precautions should be taken to avoid anaphylaxis.

With cyanosis and respiratory distress continuous inhalation of oxygen is most valuable, it may be bubbled through water in a flowmeter, and administered through a mask, bilateral nasal catheters, or the patient may be placed in an oxygen tent. The rate of administration should be adjusted so that a concentration of oxygen of more than 40 per cent is maintained in the alveoli.

Cardiac failure is frequent in the later stages of the disease, and on this account many physicians administer digitalis by mouth from the commencement, but its value is doubtful. Repeated hypodermic injections of so called cardiac tonics, such as strychnine or camphor, are to be deprecated. Alcohol in the form of brandy or champagne is of use to allay anxiety and induce sleep. In alcoholics it is essential for the prevention of delirium tremens. Abdominal distension may be a distressing feature adding to the respiratory embarrassment. It must be relieved by turpentine enemata, followed, if necessary, by intramuscular injections of pituitrin or eserine.

Insomnia is one of the most dangerous symptoms and must be prevented at all costs. Chloral bromide, or Dover's powder should be tried, but if they prove ineffective it is not justifiable to withhold hypodermic injections of heroin, hyoscine, or morphia.

Pain due to pleurisy may be relieved by local applications, such as antiphlogistine, an electrically heated pad, and by strapping the affected side of the chest, or, if necessary, by inducing a small pneumothorax. Unproductive cough is best treated with a linctus (syr codinae, syr prun. Virg aa ʒii, prn), while an alkaline expectorant containing potassium iodide (pot. iod. gr. iii ammon. carb. gr. iii tinct. scillae M℥ss aq. chloroformi ad ʒss) renders the expectoration of sputum, otherwise thick and viscid, an easier matter.

Pyrexia is part of the protective reaction and should not be treated unless dangerously high, and antipyretics are never beneficial. A temperature of 104.5° F. or over indicates the need for tepid sponging.

An abundance of fluid containing glucose should be taken, and sufficient light food in the form of milk, jellies, and fruit juice with sugar to maintain nutrition. Laxatives are given to aid elimination. The possibility of the patient getting out of bed and throwing himself from a window while delirious must be guarded against.

Ample time should be allowed for convalescence, and work

should not be resumed for about two months after the crisis. Psychoneurotic symptoms are common in those who return to their routine duties too soon. The patient should be trained in and should frequently practise for several months exercises to restore full mobility and expansion in the lung. These exercises are of the greatest importance in children. If carried out as a routine, the incidence of sequelæ such as bronchiectasis would be considerably reduced.

VARIETIES OF LOBAR PNEUMONIA

Study of the variations in the clinical course of pneumonia have suggested that the various types of pneumococci tend constantly to give rise to fairly characteristic disease forms. Further investigation is, however, necessary before these can be distinguished with any certainty.

Apical Pneumonia, by which is meant involvement of an upper lobe, is seen most commonly in children, in whom it is no more dangerous than other forms. In adults this variety is said to occur with special frequency in alcoholics and to be associated with delirium and a high fatality. In children epituberculosis in young adults pulmonary tuberculosis and in the middle aged and old bronchial carcinoma may cause difficulty in diagnosis.

Senile or Asthenic Pneumonia occurs in debilitated subjects. There may be no pyrexia nor any of the usual symptoms, and the outlook is wellnigh hopeless.

Pneumonia in Children is usually characterised by an abrupt onset with convulsions or vomiting. The course is only three to five days as a rule, and there is little danger to life unless complications occur. Empyema and middle-ear disease are however, much commoner than in adults. Empyema develops most commonly between the tenth and twentieth day, but in cases developing before the seventh day the mortality is high.

BRONCHO PNEUMONIA (*Lobular Pneumonia*)

Ætiology.—Broncho pneumonia is not a specific disease, but is an inclusive term for a variety of conditions characterised by scattered areas of inflammation in the lungs.

Primary Broncho Pneumonia is seen only in children under three years of age, and is due to infection with the pneumococcus. The symptoms and course are the same as those of pneumococcal lobar pneumonia.

Secondary Broncho Pneumonia may occur at any age, and affects both sexes equally. It is due to infection with a variety of organisms, several of which may usually be found in the affected areas of the lungs. The pneumococcus, *Streptococcus hæmolyticus*, *Staphylococcus aureus*, *B. influenzae* and *B. friedlanderi* are the most common. Tuberculous broncho pneumonia has been described elsewhere (*vide p. 113*). The infection characteristically reaches the terminal branches and air sacs *via* the respiratory passages, it is a common complication of the infectious fevers such as measles, whooping cough, diphtheria, typhoid, influenza, erysipelas and smallpox. "Aspiration broncho pneumonia" results from septic material being drawn into the bronchioles by the respiratory movements. This material may come from infected cavities within the lungs, for example lung abscess or bronchiectasis, from adjacent collections of pus such as liver or subphrenic abscess which may rupture into the lung, it may come from the mouth or throat, especially during operations under a general anæsthetic, it may follow vomiting while in a state of insensibility, and it is a common sequel in those rescued from drowning. Like lobar pneumonia, it often terminates a long illness such as diabetes or nephritis in debilitated subjects.

Pathology and Morbid Anatomy—There is reason to believe that local atelectasis, caused by the plugging of small bronchioles with infected material, is a frequent, if not an invariable, precursor of broncho pneumonia. The lesions are bilateral in 82 per cent of cases (Holt) and the parts most commonly affected are the posterior portions of the lower lobes. Small effusions into the pleural sacs are by no means rare. On the surface of the lungs are seen blue depressed atelectatic areas which are separated from one another by areas of compensatory emphysema, and there is roughening of the pleura over the more superficial areas of consolidation. The latter are felt as firm nodules when the lungs are handled, and on section the consolidated areas project above the cut surface. They vary in colour and size, the more recent are dark red and the older are gray or yellow. The lesions are grouped round a small bronchus which is filled with pus, the air sacs are filled with exudate, and beyond these are areas of congestion and of atelectasis. In severe cases a focus may necrose with formation of an abscess or wide areas of lung tissue may become gangrenous, but in milder cases ending in recovery the inflammatory changes may subside and leave no permanent alteration of structure. Organisation of the exudate with formation of fibrous tissue, persistent atelectasis,

and ultimately bronchiectasis, occurs most commonly in children

Symptoms—The onset is usually insidious, but after a few days the toxæmia is severe, with languor, tachycardia, dyspnoea, and cyanosis. The temperature rises gradually and is very irregular, usually higher in the evening than the morning, and varying from day to day, there may be no pyrexia at all, even in cases terminating fatally. Pain is seldom severe and it may be absent, but there is often restlessness and distress, while the respirations are shallow and sometimes as rapid as fifty a minute. The sputum is muco purulent, it is sometimes streaked with blood, and free hæmoptysis is seen in the influenzal form, but rusty sputum like that of lobar pneumonia does not occur. Drowsiness and delirium are common in cases showing lividity. The disease runs an irregular course, lasting from two to five weeks. Death results from exhaustion, anoxæmia, or cardiac failure, but at any stage the symptoms may subside and recovery take place. Secondary broncho pneumonia has a high mortality. Complications, except heart failure, are not frequent, but sequelæ in the shape of fibrosis and bronchiectasis are common.

Physical and Radiological Signs—In the early stages, signs of consolidation are usually absent, but there may be obvious evidence of bronchitis. Cyanosis is common. After a few days careful auscultation of the lower lobes will generally reveal limited areas of tubular breathing with pectoriloquy and fine crackling râles. If the lesions become confluent extensive signs of consolidation may be obtained. *X-ray* examination shows multiple variously sized scattered shadows throughout the lungs, concentrated commonly in the lower zones. Many of these may become confluent and so form an area of consolidation. In such areas resolution is relatively slow. Co-existent atelectasis may be seen.

Prognosis—Primary (pneumococcal) broncho pneumonia is frequently fatal in infants, but in children it runs a short course and recovery is the rule. Secondary broncho pneumonia has a more prolonged course, and it must always be regarded as a dangerous condition, especially at the two extremes of life. Restlessness, lividity, a pulse rate higher than 130 in an adult, and a low blood pressure are signs of grave import.

Treatment—Treatment is carried out on the same lines as in lobar pneumonia. Injections of sera are ineffective but if on bacteriological examination the infecting organism proves to be one which is sensitive to chemotherapy this method should be used in the way described. In certain cases it may be

advantageous to combine with these measures the administration of a vaccine or vaccoid. As the fever may last several weeks, special attention must be paid to nutrition, and frequent feeds should be given. The diet consists of milk with prepared cereals, or beaten eggs, jellies, and abundance of sugar. The early administration of expectorants, together with frequent periods of inhalation of oxygen containing 7 per cent carbon dioxide by preventing the spread of lobular atelectasis may abort the disease. Oxygen therapy is very important. It should be given by mask or tent for long periods, and if possible, in sufficient amounts to relieve cyanosis and dyspnoea. Consecutive heart failure needs energetic treatment.

Breathing exercises from a very early stage may also diminish further development of the infection, and if continued may prevent bronchiectasis.

UNRESOLVED PNEUMONIA

In most cases of acute lobar pneumonia, the exudate in the alveoli becomes completely liquefied before the tenth day, and the lung soon recovers its normal consistency and function. In a few cases, however, this sudden change does not occur, especially when bronchial obstruction and atelectasis complicate the infection. The persisting exudate becomes invaded by blood vessels and connective tissue cells, so that in course of time a network of fibrous tissue is formed in the affected lobe, which becomes shrunken, pale, and tough. Infecting organisms breed in the stagnant bronchial secretions, and the walls of the tubes become softened and dilated. Pneumococci are found in the lung, but these are seldom in pure culture, and there is usually a mixed infection with the influenza bacillus or the *Streptococcus viridans*.

Confluent broncho pneumonia is probably the commonest cause of fibroid change in the lungs, in such cases the process is more diffuse and affects areas in the lower portions of both lungs. Less common causes are empyema and pleural effusion.

Symptoms—Following an attack of broncho or lobar pneumonia the patient fails to improve. The pyrexia seldom exceeds 102° or 103° F., but it persists for several weeks and sometimes for months. There is cough, blood stained or purulent sputum, pain in the side, and dyspnoea, but the toxæmia is usually less profound than that of acute pneumonia. The pyrexia subsides gradually, and the patient is able to resume his occupation, but there is permanent limitation of his capacity for exercise, cyanosis, dyspnoea and a persistent

productive cough. As the fibroid change develops he becomes subject to recurrent attacks of bronchitis, and in some cases to spasmodic asthma, while bronchiectatic change is shown by purulent sputum and hæmoptysis. In the presence of secondary bronchiectasis the lung may be the seat of repeated attacks or relapses of pneumonic consolidation, which may recur every few months for many years, each attack being accompanied by toxæmia and pyrexia, lasting from six to ten days.

Physical and Radiological Signs—During the stage of consolidation, the physical signs may be indistinguishable from those of acute pneumonia, with dullness, tubular breathing, bronchophony, and pectoriloquy over an area corresponding to one of the lower lobes. In most cases, however, there is dullness corresponding to the affected area, while breath and voice sounds are greatly diminished in intensity. As the consolidation clears and is replaced by fibroid change new physical signs appear. The fingers become clubbed, the affected side of the chest immobile, the intercostal spaces narrowed, the vertebral column is curved laterally with its concavity towards the affected side, and the heart is displaced towards the fibroid lung. Percussion reveals less impairment of resonance, the breath sounds in the absence of bronchiectasis may be of normal character though less loud than over the normal lung and numerous moist râles are heard over the fibrotic lobe. If a relapse of the pneumonic inflammation occurs the affected lobe again becomes dull to percussion the râles disappear, and the breath sounds become inaudible.

Variable X-ray appearances are seen. Commonly with consolidation an irregular opacity of fluctuating density is found associated with outlying ill defined smaller shadows. Mediastinal structures are commonly displaced toward the lesion and the pleura is generally markedly thickened.

Diagnosis—In the stage of consolidation, pleural effusion is often suspected but the signs differ in that the cardiac impulse is not displaced away from the affected side, the dull area corresponds in shape to a lobe of the lung, and does not have the oblique upper limit sloping downwards from axilla to vertebral column which is typical of effusion. Moreover tactile fremitus is not completely abolished. In the relapsing type, clubbing of the fingers with tachycardia, dyspnoea on exertion, and bouts of pyrexia may lead to a mistaken diagnosis of infective endocarditis, but careful examination of the chest and recognition of the characteristic short periods of pyrexia should prevent confusion. When the lung becomes fibroid, hæmoptysis may suggest phthisis, and many of these

patients are sent to sanatoria. Distinguishing features are the absence of abnormal signs at the apex of the lung even when the upper lobe is affected, the absence of tubercle bacilli in the sputum, and the entirely different X ray appearance.

Prognosis—The disease is not often fatal, but it leads to permanent impairment of health unless treatment is intelligent and persevering. Profound toxæmia, especially if accompanied by mental disturbance, is an indication of danger.

Treatment—Bronchoscopy should be performed as soon as it becomes apparent that bronchial obstruction has complicated the course of pneumonia. The above mentioned signs or undue delay in resolution will suggest this. If the obstructing plug of debris can be found it should be removed by suction. Great benefit is derived from remedial exercises designed to distend and restore mobility to the affected lobe. The exercises should be commenced at a very early stage and before fibrotic changes have become established, but even years later it may be possible to achieve some measure of success. The treatment must be carried out frequently, and practised assiduously several times daily in some cases for years. Distension of the affected lung is obtained by deep breathing while the sound side of the thorax is immobilised. The patient lies on the healthy side with the hip and shoulder supported on a low couch and a hard bolster under the lower ribs. His legs are unsupported and the feet rest on the floor, while he steadies himself by grasping a support with the uppermost arm extended over his head. He then takes a series of slow deep breaths, and with each inspiration an assistant lifts him clear of the couch by hands placed under the lower part of the chest. Thus during inspiration the patient's weight is thrown on the sound side of his chest, and he is in such a position that the ribs of the healthy side are crowded together and fixed, but the opposite chest wall is expanded. A minor adjunct to the treatment is the inhalation of antiseptic vapours such as creosote or turpentine. Autogenous vaccines are often administered, but in the writer's experience have had no effect.

OTHER VARIETIES OF PNEUMONIA

Pneumonitis—The use of this term, which means inflammation of the lung, has grown during the last decade. A heterogeneous group of conditions are covered, including those discussed above and in this section, pulmonary suppuration in addition to multilobular atelectasis, and a variety of specific

infections of the lung. In view of the absence of a precise meaning the term is best avoided.

Fat Embolism—Following severe wounds especially those associated with bony fractures, more or less extensive fat embolism may occur in the lung. The onset is common some seventy two hours after injury, may be associated with evidence of multiple emboli elsewhere *e.g.* brain and skin, and a clinical course resembling broncho pneumonia often follows. Fat droplets may be identified in the sputum.

Septic Infarcts—Following operation, or associated with septic thrombophlebitis, or pyæmia multiple infarcts may occur throughout the lungs and these may each lead to necrosis and abscess formation. A variety of organisms may be concerned, particularly the staphylococcus. The condition at first resembles an acute broncho pneumonia, later its more severe course the increasing volume of purulent sputum and the radiological appearance of multiple abscess cavities are fairly characteristic, while the causal factor may be obvious. Appropriate chemotherapy is desirable from an early stage.

Virus Pneumonia—Occasional epidemics of atypical pneumonia occur in which clinical and bacteriological evidence suggests that a virus infection may be responsible.

Chronic Pneumonia—Not infrequently from the onset which is insidious pneumonia may be chronic. Variability is considerable thus in the more acute forms progression to lung abscess takes place fairly quickly, in others this may occur after a long period of very slight toxæmia. In some cases called chronic diffuse broncho pneumonia by Scadding, a fairly characteristic clinical course occurred usually with a fatal outcome. The nature of the infection is inconstant, and several organisms may be concerned. Increasing dyspnoea, cough with purulent and sometimes blood-stained sputum irregular, recurrent or persistent pyrexia and toxæmia are important features as are pleuritic pain sweating anorexia and loss of weight. Tuberculosis bronchiectasis bronchial neoplasm, actinomycosis and syphilis of the lung may be with difficulty excluded. Therapy is that of unresolved pneumonia. Benign forms of chronic pneumonia are encountered particularly in children and young adults following upper respiratory infections influenza and zymotic diseases.

PULMONARY ABSCESS AND GANGRENE

Ætiology—The two usual causes of lung abscess are
(1) Aspiration of a foreign body or infected material into the

bronchi, and (2) the suppuration of a pneumonic area, which is much less common in lobar than in broncho pneumonia. Other and less frequent causes are chronic pneumonia, septic emboli, bronchiectasis, malignant growths, rupture of an empyema or subphrenic abscess, syphilis, tuberculosis, perforation of the œsophagus, and liver abscess.

The above conditions may also cause gangrene of the lung in cases in which the toxæmia is overwhelming.

Aspiration abscesses are mostly seen after operations on the nose and throat, such as tonsillectomy, and after the extraction of teeth. Experimentally a lung abscess can only be produced by the combination of bacterial embolism and bronchial obstruction.

Morbid Anatomy—A recent abscess appears as an irregular cavity with ragged walls, containing shreds of foul smelling dead tissue, surrounded by a more or less extensive area of pneumonic consolidation. Older cavities have smooth fibrous walls and may be crossed by branches of the pulmonary artery and by thrombosed veins. Aspiration abscesses are more common in the upper lobes, and post pneumonic in the lower. Gangrene of the lung differs pathologically from abscess only in that it is more extensive, and that the patient often dies before cavitation takes place. The lung is œdematous, necrotic, and diffuent, and may be black, brown, or greenish grey in colour. A widespread pneumonia is present in the remaining viable tissue around the periphery of the gangrenous area.

Symptoms—In aspiration abscess the symptoms are not obscured by a preceding pneumonia, one or two days after the inhalation of infected material, cough and pyrexia develop, and after an interval purulent sputum appears. The sputum may be tinged with blood, and after rather more than a week it becomes extremely offensive, on examination it resembles that found in bronchiectasis, but contains shreds of lung tissue. The pyrexia is of the hectic type, cough becomes more and more distressing, and large quantities of sputum are brought up during the twenty four hours. After profuse expectoration the patient is usually temporarily better. After a month or two the symptoms may subside, and the abscess heal, more frequently it fails to do so and the clinical features of advanced bronchiectasis develop. Death occurs either from broncho pneumonia, profuse hæmorrhage, cerebral abscess, or from gangrene of the lung. The last condition is manifested by high sustained pyrexia, rapid loss of flesh, and foetid sputum which is fluid and of a greenish or dark brown colour.

Physical and Radiological Signs—If the abscess is near the surface there will be signs of consolidation, or, more commonly, a pleural rub associated with limited movement, impaired note, a poor air entry, and râles. In some cases of chronic lung abscess the physical signs of a cavity may be present. Clubbing of the fingers soon develops.

Before bronchial perforation has occurred X ray films will usually show an ill defined often nearly spherical dense opacity. When free bronchial communication exists, an air-containing cavity will be present perhaps showing a fluid level, surrounded by more or less dense consolidation (vide Plate 28). A slough may be seen within the cavity. An opaque foreign body may be shown to be present. Bronchography may reveal secondary bronchiectasis, but the oil only rarely enters the abscess.

Diagnosis—The history of pneumonia or of a recent upper respiratory operation, the toxæmia, offensive sputum, and the above signs are characteristic. The condition has to be distinguished from empyema, specially interlobar empyema, neoplasm, tuberculosis, and the more chronic forms of pneumonia.

Treatment—Bronchoscopy examination is essential, as it may reveal a foreign body or a neoplasm as the primary cause of the abscess. About 30 per cent. of all cases of lung abscess heal, either spontaneously or as the result of purely medical treatment. This latter includes postural drainage, creosote inhalations, expectorants and such drugs as neoarsphenamine and emetine. Sulphonamides are of relatively slight value.

The majority of cases, however, fail to react to these measures and, though each case must be judged individually, it is in general true that surgical intervention is more likely to be successful than continued medical therapy if the abscess shows no sign of healing after two months.

Surgical therapy includes external drainage, lobectomy, pneumonectomy, and thoracoplasty.

NEW GROWTHS OF THE LUNG AND BRONCHI

Secondary Neoplasms—Secondary growths are more common than primary. Carcinomatous deposits may be secondary to cancer of the prostate, testis, breast, stomach, rectum or any other organ and are frequent with hypernephroma. Secondary sarcomata are usually either melanotic or metastases from a tumour in one of the bones.

Secondary growths are usually numerous and scattered in

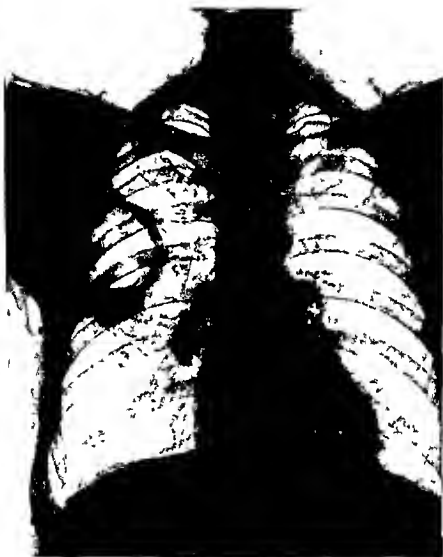


PLATE 28—Pulmonary Abscess situated in the Right Upper Lobe (Axillary Segment) The film shows a well marked fluid level and dense surrounding pneumonia

both lungs, those on the surface form umbilicated projections, while the deeper ones appear as pale rounded nodules. They cause an increasing dyspnoea, cachexia, and fever. Physical signs are often slight or absent until pleural involvement occurs. X ray often shows multiple scattered "puff ball" shadows. The pleura is affected in the great majority of the cases with effusion of fluid which may be clear, blood stained, or purulent.

Bronchial Neoplasms—Primary bronchial growths are by no means rare. The incidence is highest in the middle period of life, and men are affected more often than women.

By far the commonest primary neoplasm within the lungs is the bronchial carcinoma. Arising from the bronchial epithelium, usually near the hilum, it leads to bronchial obstruction, with peripheral pulmonary collapse and secondary pneumonia, bronchiectasis, or abscess. The growth may spread into the lungs and frequently involves the pleura. In such cases a pleural effusion usually occurs which is commonly blood-stained, occasionally serous, and not infrequently secondarily infected.

Metastasis occurs early in the mediastinal glands, and may spread thence to other lymph glands, while secondary deposits are commonly also found in the liver, brain, bones, kidneys, and other organs. The primary growth may be of the undifferentiated "oat celled" type, or show attempts at the formation of alveoli, or it may undergo metaplasia giving rise to a squamous celled carcinoma. Endothelioma of the lung and the more malignant primary sarcoma are known.

Primary innocent tumours of the lungs and bronchi are very rare. They include fibroma, adenoma, lipoma, and chondroma. More frequently innocent tumours within the thorax are extra pulmonary (vide p 660). Innocent bronchial tumours cause cough, hæmoptysis, and ultimately bronchial obstruction with all its consequences.

Symptoms—The chief symptoms of bronchial carcinoma are cough, expectoration, shortness of breath, pyrexia, and pain. The sputum is often blood stained, the blood being dark and intimately mixed with mucus, giving an appearance which has been likened to prune juice. Pain is generally not very severe, but it is remarkably persistent and differs from that of other pleuritic conditions in that it does not subside when effusion takes place. In the later stages the patient suffers from distressing dyspnoea, cyanosis and loss of strength, but wasting is only moderate, he lies on the affected side and

is subject to sudden attacks of suffocation. Secondary involvement of the mediastinal glands may lead to the mediastinal pressure syndrome described on p. 659.

In many instances the predominating symptoms are due to septic absorption from pulmonary suppuration, or from empyema. Death results in from six to eighteen months from cachexia, metastasis, right-sided heart failure, or sudden hæmorrhage into a pulmonary abscess.

Physical and Radiological Signs.—Effusion of fluid into the pleural cavity often masks the signs of the bronchial carcinoma. Aspiration may show the fluid to be blood-stained, and cytological examination may reveal tumour cells in the centrifuged deposit, or in the particles of tissue remaining in the lumen of the needle. When there is no effusion, the signs are variable and include clubbing of the fingers, and those of collapse of lung (*vide* p. 614).

Radiologically atelectasis of part or the whole of a lung, with or without a hilar opacity, may be seen. On other occasions an opacity spreading diffusely out from the hilum is found, while a peripheral neoplasm commonly appears as a somewhat spherical uniform opacity. Secondaries in the mediastinal glands, septic complications in the lung, and pleural effusion frequently complicate these findings. Branchography may reveal the site of the growth, as may tomography (*vide* Plate 26, p. 606).

Diagnosis.—In many cases there is difficulty in distinguishing primary growth of the lung from tuberculous disease. Malignant effusion is more often blood-stained than is tuberculous, and a characteristic feature is persistent pain, whereas in tuberculous pleurisy the pain disappears as soon as the inflamed surfaces become separated by fluid. If there are signs of disease in the lung, these will involve the apex in the great majority of tuberculous cases, while with growth the apex may escape even if the tumour be in the upper lobe. Of greater difficulty is the distinction of bronchial carcinoma from lung abscess, or chronic pneumonia; indeed, they may co-exist. Clinical and X-ray appearances may not be decisive. As a rule, the diagnosis may finally be made following bronchoscopy, with removal of a portion of the growth for histological examination. Carcinoma cells are expectorated in the sputum, and should be sought for by Dudgeon's method. In the rare examples of peripheral bronchial carcinomata thoracotomy may be essential not only for diagnosis but as a preliminary to treatment.

Treatment.—In the great majority of cases treatment has

little effect in delaying the fatal termination. Deep X ray therapy often diminishes the severity of the symptoms, but seldom prolongs life for more than a few months. Insertion of Radon, either by means of a bronchoscope or at thoracotomy, may afford relief. Rarely peripheral carcinomata may be successfully removed by lobectomy or pneumonectomy.

THE PNEUMOKONIOSES

Pneumokoniosis is the term given to changes in the lungs resulting from the inhalation of certain dusts.

While a wide variety of organic dusts can cause bronchitis, and dusts such as those of arsenic and lead are dangerous on account of their poisonous properties, a limited group only, and in particular silica, causes the special forms of fibrosis of the lungs with which we are concerned.

The following varieties are described depending on the nature of the dust causing the disease. Anthracosis (coal) asbestosis (asbestos) lithosis (stone) siderosis (iron and other metallic dusts) and silicosis (silica).

Anthracosis is the most common and is due to the inhalation of particles of carbon. It is found in all town-dwellers, and to a marked degree in coal miners. The carbon is present in the lymphatics, pulmonary lymph nodes, and in the mediastinal lymph glands. In advanced cases it is also found under the pleural surface of the lungs, and may even choke alveoli. Anthracosis if uncomplicated by silicosis produces little structural damage apart from choking the lymphatics, and it causes no symptoms. There is reason to believe that it may afford some protection against tuberculosis.

The inhalation of dust containing silica causes in time a characteristic nodular fibrosis of the lungs. The extent and speed of production of this change have been shown to be directly proportional to the quantity of the dust inhaled and to its content of silica. It has also been shown that the pathogenic particles are always less than 10 microns in diameter and usually much smaller. Phagocytic cells remove the particles from the alveoli, and pass in the lymph stream into the regional lymph nodes and glands draining the lungs. There a low-grade inflammation is set up by the contained silica which eventually results in a fibrosis which chokes the lymphatic system. The fibrous replacement of the peripheral nodes at the bifurcations of the bronchioles gives rise to the characteristic "nodular" radiological appearance. Further inhalation in the

presence of an inadequate lymph drainage results in more massive fibrosis within the lung parenchyma itself with a consequent massive widespread fibrosis characteristic of the advanced stages.

The change is slow and progressive, and may take from two to twenty or more years to be demonstrable. Clinically, dyspnoea is the outstanding symptom. It at first limits and later abolishes any capacity for work, and with it is associated an unproductive cough, transient pleural pains, and bronchial colds. Cyanosis is present only in advanced stages of the disease. The physical signs are never commensurate with the symptoms of the disease, but in an advanced case the thoracic wall tends to be rigid, smoothly flattened in front, with raised shoulders and movement is symmetrical but very limited. The percussion note may be resonant from associated emphysema though patches of dullness from thickened pleura are not uncommon. The breath sounds are vesicular, distant and characteristically dry. There is no fever, and except in extreme degrees of the disease, no tachycardia, asthmatic expectoration, or haemoptysis, all of which may quickly appear upon the supervention of tuberculosis, to which cases of silicosis are especially prone. Throughout the disease the sputum contains silica particles which may be demonstrated microscopically using polarised light.

Siderosis, lithosis and many examples of anthracosis are even slower in development. The pathology is similar, and it seems probable that they are examples of silicosis in which the choking of the lymphatic drainage of the lungs by a primary silicotic fibrosis is complicated by the concurrent retention of metallic calcareous and carbon particles respectively.

Asbestosis is the best known of several rare types of pneumokoniosis caused by silicates. The pathology is probably essentially similar to the above, but the fibrosis is always more diffuse. Radiologically, nodulation is absent, and a reticular fibrosis, pleural thickening diaphragmatic involvement and a shaggy heart outline predominate. The clinical signs and symptoms are those of silicosis save that the disease usually takes longer to develop. The sputum, however, on simple microscopic examination contains "asbestos bodies" whose form is characteristically that of a mass of elongated dumb bells, their presence is diagnostic of the condition.

All forms of pneumokoniosis tend to be steadily progressive and the prognosis is unfavourable unless the individual is removed from the danger of further inhalation in the early stages of the disease. Complications include tuberculosis, chronic bronchitis, emphysema, bronchiectasis, and heart failure.

The most important therapeutic measures are preventive. They include devices which reduce the amount of dust inhaled, by the use of respirators and masks, efficient ventilation, and the free sprinkling of water to prevent the formation of dust. Periodical medical and radiological examination of all who are employed in occupations with this hazard permits the exclusion of phthisis, and allows the diagnosis of pneumoconiosis to be made early in the disease. In established cases the treatment is that of chronic bronchitis and emphysema while in advanced cases therapy is purely palliative.

ALLERGIC CONDITIONS OF THE RESPIRATORY SYSTEM

Some individuals are especially prone to allergic phenomena, *i.e.*, to sensitisation by foreign proteins, and suffer from anaphylactoid symptoms when exposed to the protein to which they have become sensitised. Manifestations in the respiratory tract are of two types, hay fever and spasmodic asthma. These two diseases are common in certain families, some members of which may be subject to one form and some to the other while some unfortunate individuals are subject to both hay fever and asthma. The symptoms may commence in early childhood, but the onset is often delayed until the second decade or later, after the fortieth year susceptibility to hay fever diminishes and the disease tends to die out. The incidence of both hay fever and asthma is highest in educated persons of nervous temperament and in town dwellers.

HAY FEVER

Hay fever is a severe temporary catarrhal condition of the mucous membranes of the nose and throat and of the conjunctiva which is due to sensitisation to the pollen of certain plants.

Ætiology—Sensitisation of a susceptible individual takes place as a result of exposure to large quantities of wind borne pollen, and the symptoms recur each year and coincide with the pollination of the particular plant causing the disease. In nearly all cases this pollen belongs to one of the common grasses *e.g.*, timothy grass in Great Britain and ragweed in America. Timothy grass pollinates in May, June, and July, and it is in these months that the symptoms occur. In the United States the disease is also caused by tree pollen in April, and by the Compositæ (daisies etc.) in the late summer.

Sensitive subjects develop symptoms of hay fever when the protein of the specific pollen is applied to the mucous membrane of the nose, throat, or conjunctiva, or when it is injected subcutaneously. Identification of this pollen is best carried out by skin tests, in which the various pollens or their extracts are injected intradermally or are applied to superficial scratches on the skin of the forearm. A positive reaction is shown by an urticarial wheal surrounding the scratch. If more than one pollen provokes a positive reaction, the test should be repeated with increasing dilutions of the extracts when the specific pollen will be found to give a positive test in dilutions often ten times as high as the others.

Symptoms—The symptoms recur at the same season each year, usually from May to July. They do not persist throughout this period, there are periods of remission and exacerbation corresponding with variations in the amount of pollen suspended in the air. The attacks commence with itching and burning sensations in the eyes and nose, followed by profuse lachrymation, running from the nose, and sneezing. There is usually some malaise, and occasionally severe headache and depression. The affected mucous membranes become red and swollen and some oedema of the eyelids is common.

Diagnosis—The condition is distinguished from coryza by its regular recurrence in the early summer, and the diagnosis is confirmed by skin sensitisation tests with the grass pollens.

Treatment—Treatment should be commenced twelve weeks before the date when symptoms are expected. The specific pollen having been identified, further skin tests are made to determine the greatest dilution which will provoke a local reaction. An extract which is just too dilute to provoke a reaction is then selected, and 2 minims of this solution are injected subcutaneously. Further injections are given at five or seven day intervals, the dose being at first doubled on each occasion. If symptoms of hay fever follow an injection the next dose must be reduced and further increase made with caution. Pre seasonal treatment is the most useful, but in some cases benefit is derived from a continuance of the injections throughout the period of pollination. This treatment is successful in diminishing the intensity of the symptoms in the great majority of cases and completely prevents them in about 10 per cent., it must be repeated each year.

When the symptoms have become manifest, they can only be abolished by removal of the patient from contact with the specific pollen by sending him to a mountain resort or on a sea voyage. He may obtain some relief by wearing dark

glasses, by the subcutaneous injection of increasing doses of adrenalin, spraying the nose and conjunctivæ with a solution of adrenalin 1 in 5,000, or by taking $\frac{1}{2}$ gr. tablets of ephedrine hydrochloride twice a day. Instillation into the nostrils of a solution of 5 gr. of ephedrine in 1 oz. of liquid paraffin often gives relief.

ASTHMA

Spasmodic asthma is characterised by recurrent attacks of dyspnoea in which the expiratory movements are laboured and ineffective. The dyspnoea is due to partial obstruction of the smaller bronchi by contraction of the rings of plain muscle in their walls, and by turgescence of their mucous lining. Exceptional cases occur in which the dyspnoea is inspiratory.

Ætiology.—The musculature of the bronchi is innervated by the vagus, and experimental stimulation of this nerve, either peripheral or central, causes contraction of the smaller tubes, with all the symptoms of an asthmatic attack. Expiration, being a comparatively feeble and passive act, is interfered with to a greater extent than inspiration, consequently the lungs become overdistended with residual air, and dyspnoea with cyanosis results.

Asthma is regarded as an allergy comparable with urticaria or hay fever, and has in many instances been shown to be caused by sensitisation to grass pollens. It is also significant that psychoneurosis, particularly anxiety neurosis, commonly complicates the disorder, and furthermore a family history of the disease or of a related allergic condition is very frequently encountered.

The foreign protein causing asthma is usually one which is inhaled in the form of dust, or is produced by infecting organisms in the bronchi or elsewhere. The most provocative dust-proteins are dandruffs from the coats of cats, horses, dogs, and poultry, pollen from certain plants, and powdered vegetable matter such as flour and sawdust. The proteins of infecting organisms are responsible for a large proportion of the cases. In these cases the organisms are often recoverable in pure growth from the sputum following an asthmatic attack, amongst those commonly found are the *Streptococcus viridans*, pneumococcus, Friedländer's bacillus, and *Micrococcus catarrhalis*. In a small group of cases the attacks are due to ingested protein in the form of eggs, one of the cereals, or the flesh of a mammal, bird, or fish.

The specific protein can sometimes be identified by careful analysis of the history of the case, the symptoms may date from the entry of infecting organisms into the respiratory tract in an attack of pneumonia or influenzal bronchitis, attacks may occur only when the patient stays in certain localities or houses where he comes in contact with one of the domestic animals, or when he partakes of a certain food. Confirmation should be sought in skin tests, as described in the preceding section on Hay Fever, but instead of a pollen extract, the suspected proteins are applied to the cutaneous incisions direct, and a drop of 10 per cent sodium hydroxide solution is added in order to render them soluble. It is generally agreed that food proteins are seldom the cause of asthma which commences after childhood. A majority of the cases are probably due to infection, and many of them give a history of some acute respiratory disease preceding by a few months the onset of asthmatic symptoms. In several instances a patient whom we had seen during an attack of pneumonia or bronchitis, and who had made an apparently complete recovery has been sent to us some months later for attacks of true spasmodic asthma. These cases must not be confused with those of asthmatic bronchitis, in which attacks of dyspnoea occur in subjects of chronic bronchitis and emphysema. Asthmatic bronchitis differs from spasmodic asthma in that the distress is as much inspiratory as expiratory, the attacks do not begin and end with the same abruptness, and the patient is not free from signs and symptoms of respiratory disease between the attacks.

Symptoms—Some asthmatics have premonitory symptoms several hours before an attack, being warned by a vague feeling of oppression in the chest, or abdominal discomfort. The paroxysm occurs most commonly during the night, the patient is awakened by a feeling of suffocation, he sits up, and his breathing becomes more and more laboured, the expirations become longer and more wheezing, and in spite of bringing all the accessory muscles into play, fail to deflate the lungs before being interrupted by another short and spasmodic inspiration. The lungs become more and more distended and the thoracic movements more restricted, the face is pale and anxious and the finger tips cyanosed, but the pulse rate is little affected and there is no rise of temperature. At the height of the attack the patient is shaken by a paroxysmal cough, the sputum is at first scanty and viscid then the secretion becomes more fluid and copious, the spasm relaxes, and the patient sinks back relieved but exhausted. Attacks last from a few minutes to several hours, and may recur the same night or

only after an interval of weeks or months. After many attacks of ordinary duration, an attack may fail to terminate spontaneously, and continuing for several days and nights (*status asthmaticus*) may prevent sleep and the taking of food, and yield only to drastic treatment, or in rare instances may even result in death from heart failure.

After repeated attacks the lungs become emphysematous, so that the patient suffers from dyspnoea on exertion even between attacks, and shows the high shoulders and kyphotic spine characteristic of emphysema.

Physical and Radiological Signs—During an attack the thorax is distended and the respiratory excursions are much diminished in spite of forcible muscular efforts. There are hyperresonance and obliteration of cardiac dullness. The inspiratory murmur is short and feeble while expiration is greatly prolonged and accompanied by innumerable fine and medium rhonchi; during the later stages of the attack there are râles.

The sputum is at first viscid, and comes up in white lumps, the so called "pearls of Lannec." When unrolled, these lumps are found to consist of mucous spirals, forming moulds of the smaller tubes. In addition to these casts, which are known as Curschmann's spirals, there may be eosinophil leucocytes and octahedral crystals (Charcot Leyden crystals). Eosinophils may be greatly increased in the blood, sometimes up to 30 or 40 per cent of the total white cells. These characteristics of the sputum and of the blood count are inconstant.

The radiological findings during an attack are those of emphysema; between attacks the appearance of the lungs may be normal.

Prognosis—In young people asthma sometimes clears up spontaneously, but, unlike hay fever, it does not show the same tendency to disappear after middle age. When spontaneous recovery takes place it is usually due to a change of the patient's environment. It is doubtful whether death has ever been caused by uncomplicated asthma, but in old standing cases the lungs become affected by emphysema and bronchitis, and we have seen two patients, in whom these changes had developed, die in *status asthmaticus*. Occasionally a lasting cure may be effected by suitable treatment, and the prospects of recovery are generally best in cases submitted to treatment early in the disease, before the lungs have become emphysematous.

Diagnosis—Any of the causes of obstruction of the larynx,

trachea, or large bronchi may provoke spasmodic dyspnoea simulating asthma. Such a possibility, therefore, should be borne in mind in the investigation of these cases.

Attacks of breathlessness with wheezing respirations occur in association with severe disease of the heart or kidneys. In "cardiac asthma" (*vide p. 572*) there are usually obvious signs and symptoms of a diseased and failing heart, while "renal asthma" is usually accompanied by signs of nephritis with uræmia such as renal retinitis, albuminuria, and a considerable increase of the urea content of the blood.

Treatment—Sufferers from asthma have, in the past, been too often regarded as psychoneurotic and, their treatment being perfunctory, they have resorted to "quack" remedies or narcotic drugs, and have drifted downhill until complications such as emphysema and bronchitis rendered them permanent invalids. Systematic treatment, if not delayed too long, will cure some and alleviate the symptoms in a considerable majority of the cases.

Specific Treatment—When asthma is due to infection in the respiratory tract, the patient should be given a vaccine prepared from the organisms in the sputum and nasopharynx. Care must be taken to pick out the predominant organism, and when it has been obtained in pure growth the culture should be killed at 60° or 70° C, as a higher temperature may alter the proteins and impair the desensitising effect of the vaccine. Subcutaneous injections are given at intervals of a week, and continued until the patient has been free from attacks for several months. The first dose should be small, amounting to 2,000,000 or 3,000,000 organisms, and subsequent doses should be increased by 1,000,000 or 2,000,000 organisms on each occasion, provided the injections do not provoke an asthmatic reaction. This should be avoided, and if it occurs the next dose must be decreased. Usually the attacks diminish in frequency and severity after two or three months, and later cease altogether. Failure to obtain a good result is often due to faulty preparation of the vaccine, especially selection of the wrong organism, and it may be necessary to try several cultivations. The cutaneous tests are, unfortunately, of little assistance in selecting the specific organism. With care and perseverance about half the infective group can be desensitised, with permanent amelioration of symptoms.

Dust and pollen asthmatics are given graduated injections of the appropriate dust or pollen extract in the same manner as hay fever subjects. Considerable success has attended attempts to desensitise individuals who are susceptible to

animal emanations, especially those of the coats of horses, cats and dogs. In asthma due to food proteins the only effective treatment is avoidance of the offending foodstuff.

Non specific protein therapy in the form of intravenous injections of peptone is occasionally beneficial but is apt to provoke dangerous reactions.

Constitutional Treatment—Measures for the improvement of the patient's general condition are sometimes remarkably effective in diminishing the tendency to asthma. sources of sepsis should be dealt with achlorhydria should be remedied and a hygienic regime should be ordered. Heavy meals must not be taken in the evening as they are likely to provoke attacks. Climate has an important influence on many asthmatics and if a locality is found in which the patient is free from attacks he should if possible make his home there. Operations on the nose and throat should be performed only for the elimination of gross sepsis. Women may become affected by asthma on reaching the menopause and such cases appear sometimes to be cured by administration of thyroid extract. It is often worth while substituting kapok stuffed mattresses and pillows for the more usual feather containing articles.

Many asthmatic subjects are more liable to attacks when lying down. they should therefore learn to sleep with the head and shoulders raised on four or five pillows.

Breathing exercises are very valuable. The correction of faulty posture and muscle relaxation are first taught. Then repeated exercises are performed in order to co-ordinate and reeducate muscle action involved in the act of breathing particularly in expiration.

Palliative Treatment—Adrenalin is incomparably the best drug both for the relief and abortion of an asthmatic attack. It is given hypodermically and 1 or 2 minims of a 1 in 1000 solution often give complete relief if administered as soon as the symptoms commence. if the attack is fully developed 3 or 4 minims should be injected and without withdrawing the needle a further minim given every 30 seconds until relief is obtained. It is therefore advisable to train the patient to give himself the injection and he should carry the necessary materials about with him. Adrenalin combined for example with pine oil may also be given with oxygen as a fine spray in an inhaler. In some cases ephedrin gives similar relief and it has the advantage that it can be taken by mouth the dose being $\frac{1}{2}$ gr of ephedrin hydrochloride. Proprietary remedies usually contain stramonium the fumes of which are inhaled.

from a cigarette or ignited powder. Injections of morphia and other narcotic drugs should very rarely be given for asthma, they are less effective than adrenalin and are apt to demoralise the patient.

For oral administration the most useful drugs, apart from ephedrin are tincture of *loheha*, *grindelia*, or *stramonium* in 15 minim doses, and *liquor trinitini*, which may be given in doses which considerably exceed the official maximum of 2 minims.

DISEASES OF THE PLEURA

PLEURISY

Pleurisy is an inflammation of the pleura, which may become covered with a fibrous membrane—"dry pleurisy"—or separated by a liquid exudate. If the fluid is clear, the condition is known as "pleurisy with effusion" and, if purulent, as "empyema." These conditions are to be distinguished from non-inflammatory transudates such as hydrothorax, hæmothorax, and chylothorax, which are fluid collections resulting from lesions other than pleurisy.

Ætiology—When the signs of inflammation are confined to the pleura, the condition is termed "primary pleurisy." This not infrequently follows trauma or exposure to cold, but in the majority of instances tuberculosis will sooner or later be found to be the cause.

Secondary pleurisy is usually due to extension of disease from the lungs, and is a feature of pneumonia, tuberculosis, bronchiectasis, bronchitis, pulmonary abscess, infarct, and neoplasm. less commonly it is due to extension of inflammation from neighbouring structures, as in pericarditis, mediastinitis, subphrenic abscess, bronchial lymphadenitis, and Hodgkin's disease, it may be due to metastatic infection from tonsillitis or septicæmia, and it is commonly associated with certain chronic diseases such as nephritis.

Bacteriology—Exudates accompanying acute pulmonary disease usually yield a growth of pneumococci or streptococci, but staphylococci, Friedlander's bacillus, and influenza bacilli are sometimes found. The importance of tuberculosis as a factor in the production of pleurisy has already been stressed (*vide p. 123*).

Morbid Anatomy—The pleura is at first congested and loses its naturally smooth, shiny appearance, next, an exudate of fibrin forms, varying in amount from a delicate film to a

pasty coating $\frac{1}{2}$ in in thickness. If absorption and organisation takes place at this stage, permanent adhesions will be formed, but in many cases the dry fibrinous exudate is followed by a serous effusion. The fluid is at first clear, but may later become turbid from the presence of leucocytes, or even purulent. A blood stained effusion is usually associated with malignant growth, tuberculous disease or pulmonary infarction.

The fluid in inflammatory exudates has a high specific gravity, 1.015 or over, it is rich in protein and contains large numbers of cells. These are mainly polymorphonuclear leucocytes, except in tuberculous effusions, which show a predominance of this type of cell only in the early stage, being replaced later by lymphocytes. Bacteria are usually found in films or cultures, except in the tuberculous cases, and in these the nature of the infection can usually be demonstrated by culture or injection of the fluid into a guinea pig.

The fluid of a non-inflammatory transudate is sterile, it is of a lower specific gravity, 1.005-1.015, contains less protein, 3 per cent or under, and there are few cells, which are chiefly lymphocytes and endothelial cells.

A small effusion, persisting for only a few weeks, leads to little structural change in the chest apart from adhesion of the pleural surfaces after they have resumed contact. A large effusion, on the other hand, if allowed to remain over a long period, causes collapse of the underlying portions of the lung and so much thickening of its pleural covering that re-expansion may never take place. Fibroid changes then occur in the lung, and the chest wall falls in on the shrunken viscus.

Polyserositis, or Pick's disease, is a rare condition in which sero-fibrinous effusions occur in the pleura, pericardium, and peritoneum (*vide p 523*).

Dry Pleurisy and Pleurisy with Effusion—The symptoms, signs, and treatment of these conditions are outlined in the section on tuberculous pleurisy, they are not materially different when caused by other infections, but are more apt to be overshadowed by disease in the lungs or other organs.

Pleurisy, especially pleurisy with effusion, is almost always tuberculous when it occurs in young subjects. After middle age it is frequently due to secondary carcinoma, or it may be due to pulmonary embolism.

Dry Pleurisy—The chief symptom of dry pleurisy is pain, the character of which depends on the site of the inflamed area. Apical pleurisy causes no more discomfort than a dull ache, whereas inflammation of the more mobile parts near the lower margin of the lungs, or on their diaphragmatic

surfaces, is characterised by sharp stabbing pain which may amount to agony. This pain is greatly accentuated by coughing or the taking of a deep breath.

The characteristic physical sign is a friction rub, which is usually audible and sometimes perceptible as a tactile vibration on palpating the chest. Diaphragmatic pleurisy is not accompanied by this sign, but causes pain referred to the neck or abdomen and by its simulation of acute abdominal conditions sometimes leads to an unnecessary laparotomy. Friction sounds in the upper part of the chest are sometimes caused by movements of the scapulae, and should be excluded by altering the position of the patient's shoulder.

The pain of thoracic pleurisy is relieved by immobilising the affected side of the chest by strapping, and in diaphragmatic pleurisy a similar result is obtained by the application of a tight binder round the abdomen. Antiphlogistine, or other poultices, an electrically heated pad, or even artificial pneumothorax may be used.

Pleural Effusion—The important signs of effusion are diminished movement of the affected side of the chest, displacement of the heart towards the sound side, a flat percussion note over the lower part of the chest which reaches its highest point in the axilla, absence of voice sounds and of tactile vocal fremitus over the dull area. It should be noted that if the underlying lung is consolidated or atelectatic bronchial breath sounds and ægophony will be heard through the overlying fluid.

With large effusions mediastinal displacement may give rise to dullness at the base of the sound lung near the spine.

X-ray examination shows an opacity obliterating the costophrenic angle. With large effusions the heart is displaced and the opacity apparently extends highest on the mediastinal and costal surfaces of the thorax so that the upper edge of the effusion seems concave.

Fluid may be loculated by adhesions in any part of the pleural cavity, perhaps the commonest site being between the lobes. When loculated collections lie adjacent to the chest wall localised dullness to percussion with absent breath sound may be detected. Anteroposterior and lateral radiography will define the site of interlobar or other localised collections of fluid and will also as a rule show the presence of the adhesions which have caused the loculation and thereby will assist in diagnosis.

Treatment—The treatment of tuberculous pleural effusion is discussed on p. 126. In other cases therapy is for the

most part that of the underlying disorder. Thoracentesis which confirms the diagnosis, is needed for the full investigation of the nature of the disease, and a small quantity of the fluid should in general always be removed for this purpose, so that, for example, the cytology and bacteriology of the effusion may be established. As a rule the aspiration of large quantities of fluid are unnecessary. Exceptions occur when the effusion is so large that it causes respiratory and circulatory distress by its bulk, and when the effusion fails naturally to resolve. In the former instance, sufficient fluid should be removed to afford relief of symptoms, and after a day or so the aspiration may, if necessary, be repeated. The total volume removed at one aspiration should not exceed 1 pint, since with larger quantities the risk of causing left ventricular failure with pulmonary oedema is significant. Radiological examination of the underlying lung is facilitated by thoracentesis, with or without air replacement. In non tuberculous effusions air replacement is otherwise rarely justified.

Failure of an effusion to absorb, after say six weeks or more, is an indication for aspiration. The intravenous administration of calcium gluconate sometimes promotes more rapid reabsorption, while breathing exercises are in some cases justified, and assist in the re-expansion of the underlying lung.

Convalescence of a restful nature is essential, and should rarely be less than three months in duration.

CHEST WOUNDS

When a chest injury is sustained, shock, hæmorrhage, and later infection may any or all develop and imperil the patient's life. Since these sequelæ are common to all wounds, their clinical features and therapy will not be elaborated here except in so far as they are modified by the special localisation of the lesion. It must be emphasised, however, that the early recognition, assessment, and treatment of these conditions are vital. In particular, the commensurate use of resuscitative measures such as the transfusion of blood, serum, or plasma, and oxygen administration, together with the employment of chemotherapy with anti tetanus and anti gas gangrene sera as prophylactic measures against infection are all procedures of the first importance.

Chest wounds have special characteristics because the thorax contains and is specially adapted to contain the lungs, the heart, and the great vessels. More or less severe impairment of respiratory and circulatory function may consequently follow

this type of injury. Comprehensive yet simply applied tests of these functions have not yet been devised. Therefore, the assessment of a patient's condition in these respects, upon which appropriate therapy must be based, is largely dependent upon the ability of the clinician to evaluate the aggregate significance of the symptoms displayed, together with the extent of the anatomical damage which physical signs, radiological appearances, and other tests may show.

Injuries of the Thoracic Parietes—The impact of missiles, and crush injuries, may result in isolated or multiple fractures of the ribs and sternum. Pain, cough, and dyspnoea commonly result, and the last in cases with extensive fractures may be fatal. It is dependent upon paradoxical respiration, for, as the intrathoracic pressure falls with inspiration, the now mobile chest wall moves inwards freely, and the alveolar air passes from the underlying into the opposite lung, while, on expiration the reverse process occurs, air passing back from the sound to the injured side. This paradoxical movement may be seen and felt, and is obvious at radioscopy, which will also reveal the co-existence of mediastinal oscillation. The author has found that severe cases of this type of dyspnoea are best treated by the use of a respirator such as the Nuffield modification of the Both machine now available in British hospitals. Pain should be controlled by free injection of pericaine around the site of the fractures and the patient should remain in the apparatus until, with trial, the chest wall is shown to have recovered its stability. In less severe cases strapping and oxygen administration may suffice.

• **Hernia of the Lung**—A late consequence of fractures of the upper sternum or of the upper costal cartilages is hernia of the lung. The condition is painful, and the swelling is apparent on coughing or straining. A plastic operation is usually necessary.

Diaphragmatic Hernia—Crush injuries and penetrating wounds may produce laceration of the diaphragm which permits herniation of the abdominal viscera into the thorax. The great size of the liver usually limits hernia development on the right side, though if stomach or intestine is extruded through a diaphragmatic rent here, obstruction of the bowel is even more likely to develop than is the case on the left side. Symptoms and signs depend largely upon the size and contents of the hernia. The condition may only be discovered by chance at radiological examination or thoracotomy, with a large hernia however, the symptoms and many of the signs of a large collection of air or fluid, or both, in the pleural cavity may

appear. Mediastinal displacement may be gross and commonly the symptoms and signs are much worse in the supine posture. Borborygmi and a splash may be audible. Radiologically it may seem probable that abdominal viscera are within the thorax for colonic haustrations or the splenic shadow may be identified. The probability will be increased if the upper border of the lesion is convex and the supracent lung displaced toward the apex. In pneumothorax the lung collapses toward its root. A barium meal will confirm the diagnosis. Therapy is surgical and repair of the laceration should be undertaken before vomiting and other evidence of intestinal obstruction have developed. It is usually desirable to empty the stomach completely by means of a Ryle's tube immediately before operation and resuscitation may be a matter of urgency.

Surgical Emphysema—Surgical emphysema of the chest wall occurs in association with pneumothorax masks other signs and only occasionally causes pain and distress. Crepitation on palpation and crackling sounds on auscultation are diagnostic. Cough should be abolished with morphine and reabsorption may be accelerated by continuous oxygen administration.

PLEURAL LESIONS

Sucking Pneumothorax—The diagnosis of this condition is obvious for the lesion can be seen and heard. Paradoxical respiration occurs and the abnormal lung movements can sometimes be seen through the wound in the chest wall. Immediate closure by picking and surgical means is essential after which radiological and other investigations can be undertaken as the condition of the patient improves.

Tension Pneumothorax—This lesion is not common but may arise from penetrating or non-penetrating wounds. The clinical and radiological evidence of its presence has been discussed (*vide p. 127*). A pneumothorax needle should be inserted with aseptic precautions through the chest wall 3 in. from the mid line in the second interspace and sufficient air withdrawn by a pneumothorax apparatus to give symptomatic relief. If after coughing a rise in the recorded pressure then takes place the needle should be connected by means of a long tube passing beneath the surface of water in a Winchester bottle so that continuous drainage is insured until the valvular opening in the lung closes. In an emergency any wide bore needle will suffice to reduce the pressure temporarily. If possible a rubber finger stall with a small opening at its tip

should then be tied securely over the butt so that transport to hospital may safely take place. Coughing should be temporarily abolished with morphia.

Traumatic Pneumothorax—Like spontaneous pneumothorax this lesion frequently requires no special therapy save rest in bed while the patient is under clinical and radiological observation. Complications such as tension pneumothorax, hæmorrhage or infection can thus quickly be identified and treated as may associated lesions.

Hæmothorax—Blood commonly enters the pleural cavity from the chest wall or lung following penetrating or non-penetrating injuries. Chest wall hæmorrhage often associated with fractured ribs may need local surgical intervention. Even if hæmorrhage stops the bulk of the effusion is always augmented during the next day or so by exudate from the pleura. The fluid rarely clots *in situ*. A large hæmothorax produces symptoms of loss of blood together with dyspnoea and pain in the chest and the physical and radiological signs are usually those of pleural effusion. The lesion gives rise to considerable pyrexia so that the advent of infection can only be judged by bacteriological examination of a sample removed at thoracentesis. If the fluid is purple and has an offensive smell infection may be presumed. In these cases preliminary closed (under water) drainage by intercostal catheter is usually deemed advisable and therapy subsequently is that of an empyema. In the absence of infection small uncomplicated hæmothoraces are best treated from the onset by repeated aspiration. The pleura should be kept as dry as possible though the volume of blood removed at a thoracentesis should at first be small. Large hæmothoraces and cases with underlying lung wounds—particularly with retained foreign bodies which may subsequently need removal—should in general be air replaced completely from an early stage and the pleura kept empty of fluid. In this way pulmonary hæmorrhage may be controlled as may the intrapleural pressure. In rare cases of clotted hæmothorax thoracotomy with removal of the contents may be necessary. Since associated pulmonary atelectasis is common the diaphragm beneath the hæmothorax may be unexpectedly high—this should be remembered when aspirating or draining the lesion.

Hæmopneumothorax is common when the lung or chest wall is lacerated and should be treated on the above lines. It may however also develop as a result of gas gangrene though the visceral pleura is intact. Pressure symptoms are then added to the toxæmic effects of the infection.

Prophylactic chemotherapy and immunotherapy are especially essential in all cases of hæmothorax and treatment may later be repeated if infection develops. Blood transfusion is often necessary while oxygen therapy is of less importance. As soon as danger of further hæmorrhage from the original lesion has passed breathing exercises should be started and continued so that the fullest possible respiratory function may be restored.

PULMONARY INJURIES

Blast Lesions—It seems probable that the impact upon the body of an explosion wave whether conducted through air or water is the causal factor. The lesions tend to occur at tissue air interfaces and are thus common in the lungs and intestines. In the lungs multiple small hæmorrhages usually more extensively present on the right side occur some interstitial some alveolar associated with emphysema. As a result of both these lesions the pulmonary capillary bed is reduced in proportion to the severity of the lesion. Dyspnoea cyanosis cough and pyrexia occur as may hæmoptysis. Occasionally bronchial obstruction from clotted blood adds the complication of pulmonary atelectasis. The physical signs are usually insignificant but may include an emphysematous appearance of the chest and scattered rales. Radiologically multiple opacities indistinguishable from broncho pneumonia are seen and occasionally serial examination during the first three days will disclose an increase in the lesions. The lesions absorb relatively rapidly and the chest may be radiologically normal in less than a week. Oxygen therapy is of outstanding value while general anaesthesia and transfusions of any kind should if possible be avoided until after recovery has occurred. Every patient exposed to the hazard of blast therefore needs early and repeated radiological examination.

Pulmonary Hæmatoma—An isolated hæmatoma of the lung may follow a sufficiently severe blow on the chest wall and bruising of the lung tissue in addition to laceration is commonly produced when high velocity missiles penetrate the chest. A large hæmatoma has clinical consequences similar to those of an infarct of comparable size. Thus pyrexia cough hæmoptysis pleuritic pain dyspnoea and sometimes jaundice may result. The physical signs include superficial bruising diminished movement and air entry and an impaired percussion note. Only occasionally do the signs resemble those of consolidation. Radiologically an irregularly spherical opacity is

often seen and not uncommonly the edge of the lesion may be clearly defined. The size of the opacity may vary from a just perceptible shadow to one which involves a whole lung.

A majority of hematomata slowly resolve and during this time the patient should rest in bed and receive symptomatic treatment. Breathing exercises and oxygen therapy are of value while occasionally secondary infection of the lesion will make drainage or other surgical measures necessary.

Pulmonary Atelectasis—Lobar and multilobar atelectasis of lung occur commonly in association with a variety of chest wounds and arise as a result of bronchial or bronchiolar obstruction by for example blood sputum rupture or kinking. The signs symptoms radiological appearances treatment and sequelæ differ in no way from those described on p. 614 save that rupture of a major bronchus will necessitate early removal of the involved area of lung.

Pulmonary Fat Embolism—Bony fractures and wounds involving fatty tissues may be followed by fat embolism. The onset of symptoms generally occurs some two or three days after the injury. The symptoms include apprehension increasing dyspnoea pleuritic pain tachycardia cyanosis pyrexia and cough productive of sputum which may be frothy or blood stained and which contains extracellular fat. Physical signs commonly consist of diminished air entry and râles at the bases of the lungs though occasionally areas of consolidation may be detected. Not infrequently the clinical picture is complicated by the consequences of multiple fat emboli in the brain and spinal cord while petechiæ in the skin are also often present. Radiological signs in the chest are usually those of multiple areas of consolidation predominantly basal in site while the general haziness of pulmonary oedema obscuring the lower lung fields is also sometimes seen. Major therapeutic measures include the prophylactic avoidance of all unnecessary movement of fractured bones and in established cases oxygen therapy venesection and the general measures for the treatment of pneumonia.

Intrathoracic Foreign Bodies—Radiology, and the use of anteroposterior and lateral films will as a rule identify and localise a radio-opaque foreign body with accuracy. Anatomical localisation *e.g.* within a certain lobe of the lung is usually all that is essential unless the lung is adherent to the chest wall when depth measurements may also be necessary. Radio-translucent foreign bodies may be found at thoracotomy when surgical toilet of the track of the wound is carried out. If the condition of the patient permits it is in general wise to remove

a foreign body at the earliest possible moment i.e. within six hours of the injury for risk of infection and secondary hæmorrhage is thereby decreased. In practice this is not often possible and under these circumstances the intervening period is occupied in treating associated lesions such as shock hæmothorax or wounds of the chest wall in combating infection with chemotherapy and other measures and in resuscitating and improving the general condition of the patient. The decision if and when to operate is determined by a multitude of factors which apart from the condition of the patient include the size site and number of foreign bodies concerned. As a rule a thoracotomy is most urgent when there is evidence of continued intrathoracic hæmorrhage when a large foreign body is retained in cases of abdomino thoracic wounds and in those cases for which temporary closure of a sucking pneumothorax has already been undertaken. The operation is rarely if ever necessary in cases of clean stab or perforating wounds and foreign bodies smaller in size than the little finger nail may usually be left alone with safety. Until shock hæmorrhage or blast lesions of the lung have been adequately relieved operative intervention should be postponed while similarly priority in treatment is usually required for hæmothorax. Surgical textbooks should be consulted for further details.

CARDIOVASCULAR WOUNDS

Pericardium—Quite small quantities of blood in the pericardium give rise to pericarditis a large hæmopericardium if the wound provides inadequate drainage may accumulate rapidly and progressively diminish the ability of the heart to fill in diastole and therefore cause an increasing distension of systemic veins and a fall in the cardiac output. Clinical evidence of the latter will be found in increased dyspnoea tachycardia and a fall in the arterial blood pressure. Local physical and radiological signs of fluid or fluid and air in the pericardium may be present. Perhaps a majority of these cases are best treated conservatively particularly if pericardial drainage is adequate to prevent the development of a large hæmopericardium. Control of the latter should be attempted by aspiration. When possible a pneumothorax induction needle should be used and sufficient blood aspirated to give symptomatic relief. The pressure within the pericardium should then be recorded and the cannula left in position so that if in the next few hours the pressure again rises aspiration may be repeated. If the lesion is not controlled in this way surgical

drainage should be undertaken, at which operation it may be possible not only to repair the cardiac wounds but also to remove adjacent or impacted foreign bodies

The pericardium may become infected directly, or by spread from nearby infected lesions. A pyogenic pericarditis results, and will usually require surgical drainage. The presence of other lesions, such as pulmonary hæmatoma, or hæmo pneumothorax by masking physical and radiological signs frequently makes diagnosis difficult.

Retained Foreign Bodies—A few cases survive and reach hospital with foreign bodies in the heart muscle or within the organ. Accurate localisation of the foreign body is often possible radiologically, and after adequate resuscitation if the foreign body be large or sharply pointed surgical removal with drainage of the pericardium should be attempted. When the foreign body is within the left ventricle or auricle it may be preferable to await its ejection and then remove it from a peripheral artery.

A foreign body adjacent to the heart may cause delirium cordis and gross circulatory collapse without inflicting anatomical damage to the heart. Such a complication constitutes an added reason for the early removal of the foreign body. Circulatory failure also accompanies many cases in which marked mediastinal oscillation occurs (*e.g.*, in massive collapse and pneumothorax).

Cardiac Contusion—Occasionally the heart is crushed between the sternum and vertebral bodies, and in young subjects this may occur without fracture of the ribs or sternum. In a severe case the clinical course is that of coronary thrombosis and since almost invariably the posterior surface of the heart is most damaged, an electro cardiogram will show changes associated with thrombosis of the right coronary artery. Oxygen therapy, venesection and the treatment of cardiac infarction is required.

Wounds of the Great Vessels—Rarely early operation may be successful in treating wounds of the great vessels. In other surviving cases aneurysm formation, including arteriovenous aneurysm may result.

The early removal of foreign bodies adjacent to great vessels may prevent such a consequence, but once aneurysm formation has occurred therapy is largely palliative. In some cases of arteriovenous aneurysm, and occasionally in the more peripheral intrathoracic cases of simple aneurysm, surgical therapy may be curative, and should be undertaken at a relatively early stage.

W D W BROOKS

EMPHYEMA

Empyema is a collection of pus in the pleural cavity

Ætiology.—Empyema is usually secondary to pulmonary disease, particularly lobar pneumonia, and less often broncho pneumonia, abscess, or tuberculosis. Other causes are intra thoracic neoplasm, subphrenic abscess, liver abscess, leakage from a cancerous œsophagus, and penetrating wounds of the chest. The infecting organism is in most cases either a streptococcus or a pneumococcus, but the influenza bacillus, staphylococcus, and actinomyces are sometimes found. In tuberculous empyema the fluid is often sterile.

Morbid Anatomy.—In the case of a pneumococcal empyema the fluid is usually thick and creamy, greenish yellow in colour, and contains thick flakes of fibrin. In streptococcal infections when fluid is first found it is thin, slightly turbid, and if allowed to settle in a test tube is seen to consist of a clear portion with only a small deposit of pus. As the illness progresses the fluid becomes more turbid and the proportion of thick pus increases, until there is almost no clear supernatant fluid. It is of great importance to appreciate the significance of the characters of the fluid in all infections of the pleura particularly streptococcal. No fluid should be regarded as pus, unless after sedimentation in a tube there is at least 90 per cent of deposit. The earlier fluids are merely purulent effusions, at this stage the condition is best called a pyothorax because there is as yet no attempt to localise the collection by pleural adhesions to one part of the chest. By the time that the fluid has thickened to become *real pus*, adhesions have formed and one is now dealing with a "localised collection of pus", this definition, and this only, should be permitted in the conception of an empyema. In neglected cases, or in those which have become chronic, a thick layer of fibrous tissue is formed over the parietal and visceral pleura, this may become a serious factor in preventing re expansion of the lung and in perpetuating the abscess cavity.

An empyema may rupture into a bronchus and be coughed up, this may lead to spontaneous cure, but usually such drainage is inadequate. Very rarely it will point externally, giving the so called "empyema necessitatis". Delayed or inadequate drainage leads to septicæmia or to amyloid disease, there is also a danger of cerebral abscess.

Symptoms and Signs—The symptoms are varied and may

often be insidious in onset. The simplest clinical picture that presented by the pneumococcal form, when the temperature either fails to return to normal, or when it again after the crisis, and assumes the remittent type, patient, instead of improving, begins to show signs of a septicæmia, there are pallor, hectic flush, sweating at night, loss of appetite and wasting. Often, especially in streptococcal cases, the presence of an empyema may be entirely overlooked owing to the severe general illness and absence of symptoms pointing to such a collection. Many tragedies are through a misdiagnosis of "unresolved" pneumonia, it is essential to bear in mind the possibility of an empyema, for too often a bitter disclosure occurs in the post mortem room.

The physical signs are the usual ones of pleural effusion although it is sometimes possible to hear loud tubular breath through the fluid, more especially in children. Edema of chest wall may be detected by pinching up a roll of skin comparing with that of the opposite side. Localised tenderness on pressure may be present just as in the case of an abscess elsewhere. High leucocytosis with a relative increase in polymorphonuclears is valuable confirmatory evidence. X ray of the chest is of great value even if taken in bed when the patient is too ill to be moved. There should be no hesitation in the repeated use of an exploring needle in doubtful cases.

Prognosis—The condition is always serious, although so in pneumococcal than in streptococcal infection. Before the age of five it carries with it a very high mortality especially in infants below one year, in these, however, empyema is usually only a contributory factor occurring in an illness associated with septicæmia, extensive pneumonia, pericarditis, meningitis, or middle ear disease. In empyema associated with pneumonia the mortality is much higher in cases in which the empyema develops before the pneumonia has resolved, i.e., syn pneumonic empyema bears a worse prognosis than meta pneumonic empyema.

Treatment—The treatment has been much confused by attempts to introduce complicated methods and by the ignoring of certain fundamental principles. The first essential is estimation of the correct time at which to operate. In the post pneumonic cases by the time the fluid is detected it is usually thick pus in a well walled-off abscess cavity, and should be treated like any other abscess by immediate drainage. The danger lies in those cases where fluid is found early during the pneumonic stage. It has been shown that the size of

opening which can be tolerated in the chest is dependent upon the vital capacity. In the stage of acute pneumonia the vital capacity may be so low as almost to equal the tidal air, and the smallest of holes made into the pleura may result in asphyxiation.

If, therefore, the turbid fluid of an early pyothorax is mistaken for the pus of an empyema and open drainage instituted, death will follow rapidly. Aspiration must be practised until the fluid has thickened to form real pus, by which time the pneumonic process has usually subsided, the fluid is limited by adhesions, and it is safe to resect a rib. In a small percentage of cases recovery follows aspiration alone.

Drainage by means of an intercostal catheter is often of great value in an ill patient. It should, however, be replaced at the earliest safe moment by a rib resection, which gives better drainage.

In all empyemata the ultimate object is to obliterate completely the abscess cavity. This is brought about by re-expansion of the compressed lung which proceeds unchecked providing adequate drainage is maintained and breathing and remedial exercises are begun early and persisted in earnestly. The value of proper breathing exercises cannot be too strongly stressed and their effective use should prevent any falling in of the chest wall or displacement of the mediastinum or diaphragm which would result in permanent deformity and impaired respiratory efficiency.

Arrest of the natural process of obliteration of the empyema cavity results in a *chronic empyema*, this is most often due to too early removal of the tube or to the use of a wrongly placed or too small tube, in others chronicity is due to disease of the underlying lung. Many of these cases are cured by establishing good drainage and giving breathing exercises, but in some a thoracoplasty may be required.

Hydrothorax.—This is a passive non-inflammatory transudate of clear fluid into the pleural cavity, and is usually a feature of general dropsy, due to disease of the heart or kidneys. The hydrothorax may be unilateral, in which case it is usually on the right side, but in renal disease it is usually bilateral. Obstruction of veins and lymphatics by lymphadenoma may produce hydrothorax.

Hæmothorax.—This is a collection of blood in the pleural cavity. Spontaneous hæmothorax is usually due to bursting of an aortic aneurysm into the left pleural cavity, an event which is rapidly fatal. Traumatic hæmothorax is most often due to injury of an intercostal artery by a penetrating wound.

The blood may remain fluid or may form a solid clot, in most it is partly fluid and partly coagulated. Early aspiration with air replacement should be attempted if the size of the hæmothorax causes distress. Often operation may be needed to control a bleeding point or for evacuation of a large collection which cannot be aspirated and which if left to organise would give rise to a long illness and later deformity and permanent disability. Infection may occur from an associated lung injury and drainage would then be required as for an empyema. A spontaneous hæmothorax may mask an underlying neoplasm of the lung, or sometimes a tuberculous focus.

Chylothorax—This term is applied to effusions of milky fluid into the pleural cavity. There are two forms of this rare condition. In true chylothorax the fluid contains fat droplets and escapes from the thoracic duct or its tributaries as a result of rupture or obstruction, in chyliform effusion the fluid contains pus and endothelial cells undergoing fatty degeneration, and is usually due to chronic tuberculous disease.

Pneumothorax, Hydro-pneumothorax, Pyo-pneumothorax.—These are usually due to tuberculous disease of the lung, and are described elsewhere, occasionally, however, they result from leakage of air into the pleural cavity through an aspirating needle or a penetrating wound. Rarer causes are rupture of an emphysematous bulla on the surface of the lung, leakage through a fistulous opening in the œsophagus, and formation of gas by anaerobic organisms infecting the pleura.

The treatment is similar to that described in the section on Tuberculous Disease of the Pleura (*vide p. 126*), except that when pyogenic organisms are present surgical drainage is necessary. A closed system of drainage is preferable, combined with irrigation of the cavity if a bronchial fistula is not present. As thoracoplasty is usually needed to cure a tuberculous pyothorax the drainage tube should not be inserted where it would interfere with the incision for this later operation. The best place is at the back as low as the tenth or eleventh rib, failing this it should be well forward and low down in the axilla. The re-expansion of the lung can be aided by the addition of a controlled negative pressure applied to the closed system of drainage. Tuberculous pyothorax carries with it a high mortality.

R. C. BROCK

DISEASES OF THE MEDIASTINUM

Mediastinitis—Acute pyogenic mediastinitis occurs as the result of the spread of infection from the neck, œsophagus, or

trachea and follows for example ulceration due to impacted foreign bodies or to neoplasms. It may also complicate empyema pericarditis wounds of the chest and pyæmia.

Substernal pain cough fever and dyspnoea are outstanding symptoms.

In many cases chemotherapy is worthy of a trial while staphylococcal antitoxin should also be used in cases due to that organism. Therapy is otherwise surgical and the prognosis is in any case serious.

Syphilitic Mediastinitis—This is an increasingly rare disease in which the clinical and radiological appearances may simulate mediastinal neoplasm or aortic aneurysm. The patient complains of cough and increasing dyspnoea. Gummatous ulceration of the sternum and anterior chest wall may have occurred and thus persistent sinuses may be present. The gummatous mass in the mediastinum as a rule obstructs the superior vena cava causing cyanosis and venous congestion in the head neck and arms. The Wassermann reaction is positive and therapy should at first consist of large doses of potassium iodide after a prolonged course of which other antisyphilitic treatment may be instituted.

Tuberculous Mediastinal Lymphadenitis—*Vide p. 130*

Mediastinal Neoplasms—Mediastinal neoplasms as a class give rise to symptoms and signs which are for the most part dependent upon pressure on neighbouring structures.

The superior vena cava or one of its main tributaries may be obstructed with the production of venous congestion cyanosis and œdema in the area concerned. Dilated and tortuous veins are visible on the front of the chest and on the abdominal wall. Through these blood passes downwards and ultimately reaches the inferior vena cava. Arterial obstruction may cause unequal radial pulses unilateral clubbing of the fingers and sometimes thrombosis with gangrene.

Dysphagia results from œsophageal obstruction and chylous effusion from involvement of the thoracic duct. Pleurisy with or without effusion occasionally arises. Paralysis following a phase of irritation of the recurrent laryngeal the vagus the sympathetic the phrenic or intercostal nerves may occur.

Pressure on the trachea gives rise to a characteristic 'brassy' cough and later to dyspnoea and stridor while bronchial obstruction from similar causes provokes somewhat similar symptoms and in addition may result in atelectasis and secondary suppurative changes in the area of lung affected.

Finally pressure on bones causes erosion a constant boring

pain, and in the case of the spine ultimately gives rise to paraplegia. Radiological examination, including screening a barium swallow, and bronchography is of great value in diagnosis. Neoplasms causing these symptoms and signs may be primary or secondary.

Sarcoma and more commonly carcinoma in various primary sites may have mediastinal metastases. It is unusual in cases dying of bronchial carcinoma to find the tracheobronchial or paratracheal mediastinal glands free of neoplastic change.

Innocent primary tumours include retrosternal goitre, thymoma, chondroma, lipoma, endothelioma, neurofibroma, and teratoma. Of these the last two are as a rule situated respectively in the posterior and anterior mediastinum, and, while the thymoma overlies the root of the heart, the retrosternal goitre tends to occupy the superior mediastinum in the thoracic outlet. Any of these tumours may undergo malignant changes. Treatment is surgical.

Aneurysm of the aorta is not uncommon, and is perhaps the best known of the mediastinal tumours (*vide p. 577*). It is worth remembering that the rare isolated congenital dextro-position of the aorta regularly produces dysphagia with the advent of arteriosclerotic change within its walls. Oesophageal pouches and dilatation of the oesophagus, such as that produced by achalasia of the cardia, may give rise to bizarre symptoms and signs referable to other mediastinal structures, while oesophageal neoplasms occasionally are productive of clinical changes of the type recorded above.

Finally, lymphoma (Hodgkin's disease and lymphosarcoma) constitutes a common mediastinal tumour and very frequently appears to originate in the mediastinal glands (*vide p. 371*).

W D W BROOKS

RENAL DISEASES

RENAL FUNCTION

FOR all practical purposes the chief function of the kidney is the elimination of waste products and excess water from the body that is—excretion. In the exercise of this function the kidney plays a part of fundamental importance in the regulation of the reaction and osmotic equilibrium of the blood and tissues. Subsidiary duties, such as the elaboration of ammonia and hippuric acid, and the breakdown of the more complex ketones, formerly regarded as evidence of other than excretory functions, are now believed to be steps in preparation for excretion. If there are other specific functions, little or nothing is known of them.

The vast majority of the substances normally eliminated in the urine are brought to the kidney already formed in the blood. Transference from blood to urine alters their relative concentrations but does not change them chemically. Concentration, then, is the essential feature of the process of excretion by the kidney, and is by far its most important function. Normal renal function means ability to concentrate to a normal degree, and failure to do so constitutes *impairment of renal function*. Concentrating ability is directly proportional to the number of functioning renal units or *nephrons* (i.e., a glomerulus with its corresponding tubule), of which there are slightly less than one million in each adult human kidney. Under ordinary circumstances only a small fraction of this number is actively engaged at any one time, but under conditions of stress all may be employed simultaneously. There is therefore an enormous *renal reserve*. Because of this large reserve it is possible for disease of the kidneys to become quite extensive before a sufficient number of nephrons is put out of action to affect the ability to concentrate. Indeed, it is computed that not until between two thirds and three-quarters of the total renal substance (i.e., total number of nephrons) is rendered inactive does loss of concentrating power become

manifest Renal disease and impairment of renal function are therefore not synonymous Impairment of renal function, a diminution of concentrating power may, and frequently does occur in a "functional" sense, that is, it is not necessarily due to demonstrable structural, and irrecoverable, lesions in the kidneys Examples of this are seen in cases of pernicious anæmia with low hæmoglobin values, when, owing to deficient oxygenation, the renal cells are unable to perform their duties normally, also in cases of mechanical obstruction to the flow of urine, when increasing back pressure will give rise to impairment of renal function, which may return to normal when the obstruction is removed Recent observations indeed have shown that renal function fluctuates in a surprising manner in response to a large variety of external stimuli Such fluctuations in function may not be accompanied by any of the ordinary signs of renal disease

One of the most prominent features of the normal kidney is its ability to adapt itself to changing conditions Presented with a large quantity of fluid for elimination, it at once responds by excreting a large volume of dilute urine, or, if the fluid intake be restricted, or an excess of water be lost from the body by sweating, vomiting or diarrhoea, a small volume of highly concentrated urine is excreted Impairment of renal function may therefore be revealed either by inability to concentrate or to dilute, according to the conditions present In actual practice inability to concentrate is usually evident earlier but, with increasing impairment of function, the diluting power of the kidney is inevitably affected, with the result that finally whatever the conditions, the kidney is unable to elaborate either a very dilute or a very concentrated urine Eventually all elasticity of response on the part of the kidney is lost, and if any urine at all be formed it attains a fixed specific gravity of about 1010 (more strictly 1010) Fixity of the specific gravity of the urine at 1010 (or *isothermuria* as it has been termed by Volhard) is a certain sign of extreme impairment of renal function It may be noted that 1010 is approximately the specific gravity of the blood serum after removal of the serum proteins

Diminution of renal function may also be revealed in another way, since deficient concentration in the urine is accompanied by a corresponding accumulation of urinary constituents in the blood Such a condition is referred to as *renal insufficiency*, *urinæmia*, or, more commonly, *uræmia* Renal function may, however, be severely impaired without undue accumulation of urinary constituents in the blood when

certain compensatory mechanisms are brought into play. The most important of these is *polyuria*. Deficient concentration is for a time balanced, or compensated for, by increased volume, so that, in a given period, the total quantity of waste products eliminated is sufficient to prevent accumulation. Such a condition may properly be described as *compensated impairment of renal function* (Fishberg). Eventually, with progressive loss of function, a stage is reached in which a sufficient volume of urine cannot be elaborated, compensation fails, accumulation occurs in the blood and a condition of *decompensated impairment of renal function* i.e., *renal insufficiency*, supervenes. Renal disease, therefore may or may not be accompanied by, or progress to, impairment of renal function, whilst the latter is not necessarily so severe as to lead to renal insufficiency.

Impairment of renal function affects simultaneously the maximum concentration in the urine in which all the substances normally eliminated can be excreted, though not to the same degree. Even substances which are not normally found in the urine such as albumen, sugar, and the ketone bodies, are, in the presence of severe impairment of renal function, excreted in diminished concentration. A reduction in the concentration of albumen in the urine is therefore not always a sign of improvement. Ability to excrete water may also be impaired, as shown by a deficient water excretion test (*vide* p. 670). The extent to which the various substances are diminished in concentration in the urine when renal function becomes impaired is roughly proportional to the degree in which they are normally concentrated by the kidneys. This explains why some substances accumulate in the blood in renal insufficiency whilst others apparently do not. Creatinin and urea for example, which are normally concentrated some 80 and 60 times respectively in their passage through the kidneys, readily accumulate in the blood when renal function becomes impaired. Uric acid also accumulates in such circumstances, though not so readily, being normally only concentrated some 30 times by the kidneys. Chloride, calcium, sodium, and water, on the other hand, which are normally scarcely concentrated at all by the kidneys (i.e., their concentration in blood and urine is practically identical), do not accumulate in the blood in renal insufficiency. Phosphate, sulphate, and potassium, occupy an intermediate position in this respect. The hall mark, then, of impairment of renal function is diminution of concentrating power, whilst that of renal insufficiency is retention in the blood. The latter, like the analogous cardiac insufficiency is a relative term, when for example, there is nitrogenous

retention on a diet containing a normal amount of protein but not when the protein intake is limited. Impairment of renal function is present all the time, but renal insufficiency only under conditions of greater atress, or, to put it another way, a decompensated impairment of renal function has become compensated, in this instance, by diminishing the protein intake.

The decompensation of a previously compensated impairment of renal function is one of the most important events in the course of a case of renal disease, and may be brought about in a variety of ways. Thus, since polyuria is by far the most important factor in maintaining compensation, anything which diminishes the volume of urine may lead to decompensation. Urinary volume may be diminished for many reasons some renal and others extra renal, in origin. The only strictly renal cause of diminished urinary volume (oliguria, or anuria) is a degree of impairment of renal function so severe that the kidney is unable to eliminate a sufficient quantity of water. This is a comparatively rare event. Far more often compensation is broken by extra renal causes in which water is diverted from the kidneys into the tissues, where it becomes "bound" and is consequently not available for excretion. Extra renal oliguria is seen, for example, in myocardial failure, excessive vomiting or diarrhoea, the rapid formation of general oedema and intercurrent febrile disorders. In general, decompensation may be brought about by (a) diminished concentration, (b) diminished volume, and (c) increased katabolism.

Extra-renal Azotæmia (*Pre-renal Deviation*)—It has been seen that in renal insufficiency some substances accumulate in the blood at a greater rate than others, and that of them all urea is one of the most readily affected. For this reason and because there are several easy methods for its estimation in the blood and in the urine, this substance is most often selected as an index of renal efficiency. For practical purposes estimations of the blood urea may be regarded as indicative of the nitrogen content, and therefore of the degree of azotæmia. Renal function, in fact, has in the past been chiefly assessed in terms of urea excretion. Of recent years it has become increasingly evident that azotæmia not uncommonly occurs when renal function is quite normal, as shown by ability to concentrate all the urinary constituents, including urea, to a normal degree. An increase in the blood urea is therefore not in itself evidence of renal insufficiency. A raised blood urea associated with normal renal function is generally, and chiefly, due to a diminution of urinary volume so pronounced

that, despite normal concentration, the excretion or output of nitrogen lags behind, and accumulation in the blood occurs, though doubtless other factors also play a part, such, for example, as excessive endogenous protein katabolism in pyrexial states. It becomes of great practical importance, therefore, to be able to determine whether azotæmia (nitrogen retention in the blood), or diminished volume of urine, is due to renal, or extra renal, causes. This may readily be done if it be borne in mind that renal function cannot be impaired without evidence of loss of concentrating ability. Azotæmia, or oliguria, of renal origin will therefore always be accompanied by urine of diminished maximum concentration, *i.e.*, a dilute urine with a low maximum specific gravity and a low concentration of urea, whilst azotæmia, or oliguria, of extra renal origin will, since renal function is normal, be associated with urine of normal or high concentration, *i.e.*, with a normal or high maximum specific gravity and urea concentration. There are additional signs which serve to distinguish between renal and extra renal azotæmia, or oliguria. Thus, fluid lost from the body by vomiting, diarrhoea, or retained as œdema, has usually a higher chloride content than the blood. The blood chloride content is diminished and may approach the renal threshold value for this substance, with the result that little or practically none may be excreted in the urine. Again, loss of chloride from the body may set free an excess of base in the blood, which, combined as bicarbonate, increases the alkali reserve above normal, that is it causes alkalosis. Briefly, then, the chief features of azotæmia and oliguria of renal origin are a urine of low maximum specific gravity, low urea concentration, and normal chloride content, associated with a normal or high blood chloride, and a normal or low blood alkali reserve (acidosis), whilst the characteristics of extra renal azotæmia and oliguria are a urine of normal or high maximum specific gravity and urea concentration, and a low chloride content, associated with a low blood chloride and a high alkali reserve (alkalosis). It will be seen later that, for all practical purposes, the distinction can be made by an estimation of the specific gravity of the urine.

A consideration of the conditions which may give rise to extra renal azotæmia and oliguria, or, as they are sometimes called, pre renal azotæmia and pre renal deviation, will show that their importance in practical medicine can hardly be over estimated, especially when it is recalled that many of them so frequently complicate cases of primary renal insufficiency. Indeed, death from uncomplicated renal insufficiency

is a comparatively rare event even in renal disease. Far more often a fatal issue is precipitated by the addition of a pre renal to an existing renal azotæmia. Pre renal azotæmia and oliguria are in fact as has been stated already the chief means by which a compensated impairment of renal function becomes decompensated.

Conditions in which Extra-renal Azotæmia frequently occurs—Pronounced disturbances of the salt and water balance of the body such as occurs with loss of much fluid from vomiting or diarrhœa from any cause is likely to be accompanied by extra renal azotæmia. Thus it is frequently met with in pyloric and high intestinal obstruction in cholera and in severe summer diarrhœa of infants. Vomiting or diarrhœa from any cause is therefore a serious complication in renal disease with impaired renal function as an extra renal azotæmia is superadded and may prove fatal. In the tropics profuse sweating leads to a similar mild extra renal azotæmia so that the blood urea at least in Europeans is normally some 20 mgm per 100 c.c. higher than in temperate climates.

The mechanical withdrawal of œdema fluid by acupuncture or tapping in renal disease with anasarca but with normal renal function may also give rise to severe extra renal azotæmia with unpleasant and even fatal consequences. The œdema of heart failure affords a common example of pre renal deviation which is sometimes accompanied by pre renal azotæmia. Naturally when heart failure supervenes in chronic renal disease with impaired renal function the consequences from pre renal azotæmia are more serious. Insufficient fluid intake may occasionally cause extra renal azotæmia as in a woman in whom after an abortion the fluid intake was restricted with the object of diminishing the swelling of the breasts when increasing drowsiness was found to be associated with a blood urea of 88 mgm per 100 c.c. but with normal renal function. The œdema of nephrosis and some cases of acute nephritis are likewise in some respects examples of pre renal deviation of water. When pre renal deviation and azotæmia are associated with loss of fluid they do not develop if sufficient fluid be given beforehand. When established they can often be cured by the administration of fluid and salt. It has recently been found that extra renal azotæmia and oliguria may be prominent features after much loss of blood as in severe hæmatemesis. In other conditions pre renal azotæmia appears to be more closely associated with a peripheral circulatory failure (*vide p. 59*) in which there is a diminution in the volume of circulating blood. This appears to be the explanation

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of its occurrence in cases of surgical shock, "blast" injury, severe uncontrolled diabetes mellitus, and Addison's disease, and in all, the administration of fluids and salt is of value. The pre renal azotæmia and water deviation of pyrexial states due to increased endogenous protein katabolism, has already been mentioned. It may be noted that the former is often an important factor in the elevation of the blood urea in the early stages of acute nephritis, and is then due largely to the original infection and its accompanying metabolic disturbances. Gastric uræmia is described elsewhere (*vide p. 406*).

Although it is of great practical value to retain the distinction between renal and extra renal azotæmia, recent observations suggest that the fundamental difference between them is not so clearly defined as was formerly supposed.

TESTS OF RENAL FUNCTION

Since concentration is the chief, and, for all practical purposes, the only function of the kidneys, it follows that all tests of renal function must essentially measure the concentrating power of the kidneys. Indeed, the earliest tests of renal function consisted in noting the absence of the odour in the urine in renal disease after the ingestion of such substances as asparagus and turpentine, and the delay in the appearance of the colour in the urine after the administration of certain dyes. In both instances it was the lack of concentration of such substances in the urine which suggested impairment of renal function.

As, moreover, all the urinary constituents are simultaneously affected when the concentrating power of the kidney is diminished, it follows that any one, or all, of these constituents may properly be selected for study as an index of renal function. Practical considerations, such as the readiness with which uræa (one of the substances most highly concentrated by the kidney) accumulates in the blood in renal deficiency, and the ease with which its concentration can be estimated in both blood and urine, have led to its general adoption for this purpose, though there is no inherent reason for this. It is obvious that so far as the urine is concerned all the necessary information regarding concentrating ability can be obtained by a study of the specific gravity. Impairment of renal function, therefore, can be estimated easily and accurately by following the specific gravity of the urine, but for the diagnosis of renal insufficiency an examination of the blood is essential, and for general purposes an estimation of the urea content of the latter is the most

convenient It has been stated that the total non protein nitrogen, the creatinin, and the uric acid contents of the blood give earlier evidence of the approach of renal insufficiency It is doubtful whether such claims can be upheld and certainly in practice the advantages are negligible

Great care is necessary in interpreting the results of any method of estimating renal function Severe renal disease frequently leads to serious disturbances in other systems and organs and it is upon these that the ultimate prognosis often depends It is therefore important to remember that, whilst renal function tests afford fairly accurate information as to the extent of the local lesion if used as an index of the general prognosis they must be considered in relation to the whole clinical state Again, the conceptions of extra renal azotæmia and pre renal deviation show that deficient excretion in the urine may not be due to a fault of the kidney itself whilst *per contra* compensatory polyuria may provide an adequate excretion in spite of gross impairment of renal function In other words, inadequate excretion is not synonymous with impairment of renal function, nor is normal excretion evidence alone that renal function is not impaired All these factors must be taken into consideration in interpreting the results of any tests of renal function

At one time or another almost all substances which are capable of excretion by the kidney, and which can be readily estimated in the blood and urine, have been used as an index of renal function The number of renal function tests is therefore very large It is only possible here to describe two of the most valuable in any detail—the Specific Gravity and the Urea Clearance Tests To facilitate reference brief comments are added on some of the more important of the other tests but for details of their application larger works should be consulted

Tests from a Study of the Urine—It is assumed that the reader is familiar with the ordinary qualitative tests for blood and albumen as applied in the routine examination of the urine, and also with the common microscopical appearances of the urinary sediment

Appearance of the Urine—Taken in conjunction with the clinical findings much information may be obtained from noting the appearance and particularly the colour, of the urine With normal renal function a small volume of urine will usually contain much pigment and have a high specific gravity Absence of pigment with a small volume of urine and a low specific gravity generally indicates severe

impairment of renal function. The intensity of the pigmentation of two simultaneous specimens obtained by ureteric catheterisation will often give information as to the relative functional capacity of the two kidneys, even before chemical analysis has been carried out. In general, when much fluid is either lost from the body entirely, or diverted to the tissues in the form of œdema, i.e., when pre renal deviation occurs, the urine is highly coloured, and of high specific gravity, if renal function is normal. On the other hand, if large quantities of fluid are being consumed, or œdema fluid and serous effusions are being absorbed, the urine may be colourless and of low specific gravity with quite normal renal function, but the volume will be large.

Specific Gravity of the Urine—A study of the specific gravity of the urine, interpreted with regard to the conditions obtaining at the time, will often supply all the information required concerning the functional capacity of the kidneys. To determine to what extent impairment of function has given rise to accumulation in the blood direct analysis of the latter must be made.

In general the specific gravity of the urine varies inversely as the volume, the extreme range in health being from about 1002 to 1040, with an average of 1015 to 1020. The night urine is usually more concentrated than that passed during the day, and therefore, unless for special reasons, it is advisable to take the reading in a sample of the whole twenty four hours' output.

Information of value may sometimes be obtained by a consideration of the specific gravity alone, even in a single and casual specimen, for, if, in the absence of a large quantity of albumen or sugar, it be high, i.e., 1026 or more, renal function is certainly intact whatever the volume of urine excreted. With values lower than this no assessment of renal function can be made without a knowledge of the corresponding volume. The close inverse relationship which normally exists between urinary specific gravity and volume forms the basis of the Concentration and Dilution Tests now to be described.

The Concentration (Specific Gravity) Test—Neither fluid nor food is taken after 6.0 P.M. on the day preceding the test. The last meal should contain plenty of protein but a minimum of fluid. On retiring to bed the bladder is emptied and the specimen discarded as is any passed during the night. Sixteen hours after the last meal, i.e., at 10.0 A.M., the bladder is emptied and the specimen saved and bottled separately. The bladder is again emptied at 11.0 A.M., and at mid day, and the specimens preserved likewise. No breakfast is given until the

completion of the test at noon. Time is allowed for the three specimens to cool down to 15° C, and the specific gravity of each is then read. If renal function is normal, then at least one of the readings will be 1022 to 1035, or even 1040, though values below 1025 must be regarded with suspicion and the test should be repeated. It is sometimes necessary to increase the period of abstinence from fluids from sixteen to twenty-four hours, though this should not be done until it has been ascertained that the shorter period has proved unsatisfactory, as considerable discomfort may attend deprivation of fluid for as long as twenty-four hours. The specific gravity of small volumes of urine may be estimated by the use of Specific Gravity Beads but if less than 3 c c is available it is easier to estimate the concentration of urea, which under these circumstances should be not less than 2 per cent. The concentration test should always be performed before the dilution test when both are required.

The Dilution (Specific Gravity) Test—Just as with normal renal function the specific gravity of the urine increases with abstinence from fluid so it diminishes when the fluid intake is much increased. The test is best performed with the subject at rest in bed, as in this position excess fluid is more rapidly eliminated. Water to the amount of 1200 c c (or 2 pints) is drunk in the course of half an hour. The bladder is emptied at hourly intervals for four consecutive hours after this, and the specific gravity of each specimen (which, for reasons explained later, are also carefully measured) is taken. If renal function is normal then at least one of the readings should be below 1010, and may even reach 1002. Values above 1008 should be regarded with suspicion.

Water Excretion Test—The technique of this test is that described for the Dilution Test. For convenience the two are performed simultaneously. In four hours a normal subject will eliminate approximately the whole of 1200 c c of water taken in the course of half an hour, and for this reason the hourly specimens of urine obtained in the course of carrying out the Dilution Test are accurately measured. If, owing to deficient renal function, water elimination is impaired, then considerably less than the total 1200 c c will be excreted in four hours. There are, however, many other causes of impaired water elimination, i e, those of pre renal deviation. A poor water excretion test therefore may be due to other than diminished renal function, and this test does not differentiate between impaired water excretion due to renal and extra renal causes. If, however, poor water excretion is associated with a

normal concentration test, then impaired water excretion is of extra renal origin. *Per contra*, if diminished water excretion is associated with a poor concentration test the former may be due to either renal or extra renal causes as when cardiac failure or rapid development of cedema complicate renal deficiency.

The Urea Concentration Test—This test was devised by MacLean and de Wesselow for the rapid estimation of renal function in soldiers during the war of 1914-18. Under suitable conditions and after the ingestion of 15 gm of urea the concentration of urea should not be less than 2.0 per cent in at least one of three consecutive hourly specimens of urine. The test was admirably suited for the purposes for which it was designed and is still of use as a rough estimate of renal function.

Dye Tests—These are mostly used in surgical practice. The dyes chiefly used are indigo carmine and phenolsulphon phthalein.

Excretion Urography—In addition to its value for outlining the renal tract under X rays this procedure (*vide p. 719*) will give information of the excretory power of the kidney. After the intravenous injection of an iodine containing contrast medium a good shadow of the renal pelvis should be obtained in five minutes. Delay in the appearance of this shadow or its absence indicates defective renal excretion.

Analysis of the Blood as an Index of Renal Function—Analysis of the constituents of the blood is necessary only for estimating the extent to which accumulation has occurred therein as a result of deficient renal function. It provides evidence that urinary constituents are present in the blood in excess, but does not show whether such excess is due to renal or to extra renal causes. Any of the normal urinary constituents may be selected for analysis in the blood as evidence of the degree of renal insufficiency, but for practical purposes it is an advantage to estimate those which most readily accumulate in the blood as a result of diminished excretion by the kidneys. For this reason, urea, the total non protein nitrogen, creatinin, uric acid and phosphate, are usually selected. For all practical purposes an estimation of the blood urea furnishes all the information required.

The Blood Urea—Normally the blood contains from 20 to 40 mgm of urea per 100 c.c. In the very young and in normal pregnancy 20 to 25 mgm per 100 c.c. may be regarded as the upper limits of the normal. In the aged and in young adults in the tropics up to 50 mgm per 100 c.c. may also be considered normal. The extent to which urea may accumulate in the blood

in renal insufficiency depends upon several factors, among which are—the severity and duration of the renal inadequacy, the efficiency of compensatory mechanisms, the fluid intake, the protein content of the food, the rate of protein katabolism, and the functional capacity of the liver which elaborates urea. An abnormally high blood urea may of course be entirely due to extra renal causes when renal function is quite normal, and even in cases of extreme renal insufficiency some proportion of the increased blood urea is often due to super added extra-renal factors, such as dehydration from vomiting or circulatory disturbances in the kidneys resulting from a failing heart. Urea being an easily diffusible non-electrolyte, is found in practically the same concentration in most of the tissues of the body and therefore may be estimated in either plasma, serum, or whole blood, cerebro spinal fluid, and, with suitable precautions, in saliva. By appropriate measures (*vide p 653*) a raised blood urea due to renal insufficiency may be reduced to normal, though the patient may die from "uræmia."

Simultaneous Tests on Blood and Urine for the Estimation of Renal Function—Amhard, as a result of simultaneous studies of the concentration of urea in the blood and urine, formulated certain laws governing the excretion of urea, and embodied the results in a test for renal function. The technique of his original test however, was complicated and the validity of some of his laws was challenged, so that the method has largely fallen into disuse. Amhard's pioneer work, however, has been of immense importance in paving the way for a clearer conception of the essential nature of renal function and its estimation.

The Addis Ratio—Addis found that when the kidney is working to its maximum capacity after being "loaded" with the administration of a large dose of urea and extra fluid, the ratio —

$$\frac{\text{milligrams urea in one hour's urine}}{\text{milligrams urea in 100 c c blood}}$$

is proportional to the number of functioning nephrons. He showed that this ratio is really a measure of the volume of blood cleared of urea by the kidneys in one hour, and thus introduced the conception of the "blood urea clearance."

The Blood Urea Clearance Tests—Moeller, McIntosh, and Van Slyke developed the conception of the blood urea clearance to include not only that amount of blood which was cleared of urea in a given time when the kidney was working to maximum capacity but for conditions in which renal capacity was not fully taxed. According to these workers the kidney is always

working to its maximum capacity when urine is excreted at the rate of about 200 per minute or more. Under such conditions the rate of urea excretion is directly proportional to the concentration of urea in the blood, and the volume of blood which is cleared of urea in one minute is termed by Van Slyke the *maximum clearance*. In health this is relatively constant at about 75 cc. When the rate of urine excretion is less than 200 per minute, the amount of blood cleared per minute is not constant, but varies as the square root of the urinary volume. This is termed the *Standard Clearance*, and averages about 54 cc. The maximum and standard clearances can therefore be derived from the two following formulae, which are applied respectively according to whether the rate of urinary excretion is above or below 200 per minute —

$$\text{Maximum Clearance or } C_m = \frac{UV}{B}$$

$$\text{Standard Clearance or } C_s = \frac{U\sqrt{V}}{B}$$

where U=urinary urea in milligrams per 100 cc

B=blood urea in milligrams per 100 cc

V=volume of urine in cubic centimetres per minute

The authors give the following normal values for adults —

Maximum Clearance range 64 to 99 cc average 75 cc

Standard Clearance range 40 to 68 cc average 54 cc

It is necessary to make a correction in the case of children and adults of abnormal stature for surface area.

For comparative purposes it is convenient to convert the results into percentages. This can be done by multiplying the maximum clearance and the standard clearance figures by 1.33 and 1.85 respectively. The following are examples of the calculations for maximum and standard clearances —

MAXIMUM CLEARANCE

Blood urea 30 mgm per 100 cc

1st Hour

Urine urea 250 mgm per 100 cc

Urine volume 390 cc per minute

$$C_m = \frac{250 \times 390}{30}$$

Blood cleared of urea per minute = 325 cc

Per cent of normal = $325 \times 1.33 = 43.2$

per cent

2nd Hour

350 mgm per 100 cc

282 cc per minute

$$C_m = \frac{350 \times 282}{30}$$

Blood cleared of urea per

minute = 329 cc

Per cent. of normal

$329 \times 1.33 = 43.8$ per

cent

Mean = 43.5 per cent of normal

STANFORD CLEARANCE

Blood urea 40 mgm per 100 c c

1st Hour

Urine urea 1150 mgm per 100 c c
 Urine volume 1.52 c c per minute.

$$C_s = \frac{1150}{10} \times \sqrt{1.52}$$

Blood cleared of urea per minute 35.4 c c
 Per cent of normal $35.4 \times 100 = 63.5$
 per cent

2nd Hour

Urine urea 1300 mgm per 100 c c
 Urine volume 1.06 c c per minute

$$C_s = \frac{1300}{40} \times \sqrt{1.06}$$

Blood cleared of urea per
 minute 33.5 c c per
 cent of normal
 $33.5 \times 100 = 61.1$ per
 cent

Mean 63.7 per cent of normal.

Expressed as a percentage of the normal values below indicate renal deficiency. Symptoms of uræmia are not to appear with values below 5 per cent but not above 1 per cent. It is important to note that values below normal may be due not only to disease of the kidney itself but also to *diminished renal blood flow* e.g. *heart failure*. Repetition of the test in the same subject will often show considerable variations in the results.

The test is carried out as follows. Between breakfast and lunch (tea but not coffee may be taken with breakfast) the bladder is emptied and the specimen is discarded. Exactly sixty minutes later the bladder is again emptied and the resulting specimen is accurately measured (in cubic centimetres and not in ounces) and its urea content determined. The bladder is again emptied exactly sixty minutes later and the specimen measured and its urea content determined as before. A sample of blood is taken for estimation of the blood urea at the end of the first hour. If the volume of urine exceeds 2 c c per minute the maximum clearance is calculated; if less than this the standard clearance by means of the formulae given. It is important that the bladder be completely evacuated on each occasion and that the volume of urine be accurately measured. In subjects with marked renal deficiency the test should be performed in the recumbent position. In actual practice many observers find that the standard clearance does not always give satisfactory results and recommend that the maximum clearance be used. In order to ensure that the kidney is working to full capacity it is customary, immediately the bladder has first been emptied to give a dose of 15 to

20 grm of urea in 300 c c of water, and to give a further 300 c c of water at the end of the first half hour. Even with these precautions a fairly high proportion of subjects especially those with renal or cardiac disease, fail to give a sufficient diuresis for the satisfactory application of the test. It is of course unnecessary to give urea when the blood urea is already known to be over 50 or more milligrams per 100 c c. A further difficulty arises as it is never certain that the bladder has been completely emptied and routine catheterisation is certainly not justified.

The Urea Clearance Test is regarded as the most sensitive test of renal function at present available but its successful performance demands the most meticulous attention to details especially in the complete emptying of the bladder and in the accurate timing and measurement of the specimens of urine.

In interpreting results it is important to remember that urea clearance varies directly with renal blood flow which of course alters from minute to minute. Within a certain range therefore variations in clearance are evidence of normal response by the kidney. This normal range is from 75 to 130 per cent of the average normal. Values over 75 therefore represent normal renal function. From 75 to 50 are considered doubtful and if the following extrarenal factors can be excluded values below 50 indicate impairment of renal function —

- 1 Heart failure (this factor however would not by itself cause a reduction of more than 20 per cent of the normal clearance)
- 2 Shock or diminution of peripheral circulation as in trauma and gastro intestinal obstruction
- 3 Pre renal dehydration (dehydration) as in persistent vomiting or diarrhoea
- 4 Renal back pressure as in partial obstruction of the urinary passages from calculus or enlargement of the prostate
- 5 Reflex anuria after operations or the passage of catheters

Whilst it can certainly be affirmed that the Urea Clearance Test is superior to most of the other tests of renal function including the Urea Concentration Test it offers few advantages over the much simpler and equally accurate specific gravity tests.

Alkaline Tide and Renal Function — It has been observed that in some forms of Bright's disease the alkaline tide diminishes or disappears. Under suitable circumstances this fact may be used as an early indication of impairment of renal

those of nervous temperament and poor development. It is characterised by the small quantity of albumen present and the readiness with which this disappears with rest. It is believed to have no pathological significance and no specific treatment is required. Dublin's figures suggest a tendency for such adolescents to develop pulmonary tuberculosis. Claims that the normal albumen globulin ratio is reversed in this condition do not seem to have been substantiated.

Symptomatic Albuminuria.—Albuminuria is met with in a great variety of physiological and pathological conditions. Thus it invariably accompanies prolonged violent exertion, as in football or rowing, especially in the untrained, and may be caused by cold baths and emotional stress. It also frequently occurs with acute infections of all kinds, especially when pyrexia is present, and in passive congestion of the kidneys in heart failure, and after convulsions, as in epilepsy.

Hæmaturia.—The abnormal appearance of the red corpuscles in the urine. Blood may appear in the urine as the result of injury or disease of any part of the urinary tract or adjacent organs and in a few diseases of other parts of the body. The chief causes of this symptom may be conveniently summarised as follows —

1 Hæmorrhage from the kidneys

- (a) Inflammatory acute nephritis, tuberculosis, pyelitis
- (b) Malignant hypertension—essential hypertension ("Renal Epistaxis")
- (c) Traumatic calculus, oxaluria, injury
- (d) Growth malignant—hypernephroma, carcinoma, sarcoma
benign—papilloma, angioma, and capillary nævus of pelvis
- (e) Blood Diseases purpura, scurvy, hæmophilia
- (f) Drugs turpentine, carbolic, hexamine, luminal
- (g) Congenital cystic kidney, hydronephrosis, aberrant renal vessels
- (h) Embolism and infarction

2 From the ureter ureteric calculus—papilloma

3 From the bladder papilloma, carcinoma, acute cystitis, tuberculosis, bilharzia, engorgement of vesical veins from adenoma or carcinoma of prostate, calculus, injury

4 From the urethra trauma, acute urethritis, calculus

5 From diseases originating outside the urinary organs extension of abscess from prostate, appendix, pelvis,

pyosalpinx pyosalpinx carcinoma of uterus rectum
caecum sigmoid and pelvic colon tuberculous ulceration
of small intestine and diverticulitis

6 Contamination from other sources menstruation
cervicitis balanitis

Occasionally hematuria may occur without demonstrable cause and apparently without sequela. This has been designated 'essential' hematuria. A similar idiopathic hematuria occasionally occurs in families.

Renal Hypertension—Since the vast majority of subjects with arterial hypertension are found to have some evidence of renal disease at autopsy, the belief naturally arose that disease of the kidneys was always the cause of hypertension. It is now known that hypertension often precedes the most insignificant lesions in the kidneys by many years and that only a very small proportion of cases of primary or 'essential' hypertension die from renal disease. There are, however, other cases in which disease of the kidneys either causes hypertension or activates a latent hypertension in the predisposed. Such may be regarded as instances of Renal Hypertension. Like azotemia and edema then hypertension may be renal or extra renal in origin. Renal hypertension has often been produced experimentally by various means all of which greatly diminish the total amount of active renal tissue. Clinically renal hypertension has been observed in practically all conditions in which there is prolonged obstruction to the flow of urine from both kidneys as in bilateral hydronephrosis or enlargement of the prostate. It also commonly occurs in the later stages of congenital cystic disease of the kidney. The classical example of renal hypertension is that associated with chronic glomerular nephritis (*vide p. 197*) though it is not always present in this disease. The hypertension which so commonly occurs in the early stages of acute glomerular nephritis is of a transient nature and may be due entirely to extra renal causes. However in a small proportion of such cases the hypertension persists long after all other signs of nephritis have disappeared and then may certainly be regarded as renal in origin. The older the subject at the time acute nephritis is contracted the more likely is the hypertension to persist and this suggests that the nephritis activates a latent hypertension in the predisposed rather than causes it directly. A similar relationship seems to hold in connection with the hypertension which frequently precedes accompanies and sometimes persists after the renal complications of pregnancy. Two theories are held regarding the cause of renal hypertension—the mechanical and the

chemical According to the former, the hypertension is due to the increased resistance to the flow of blood through the diseased thickened and narrowed vessels of the kidney. The chemical theory postulates that owing to disease of the kidney pressor substances are present in excess in the blood. The work of Goldblatt and others who experimentally constricted the renal arteries in animals now makes it almost certain that both factors play an essential part and that renal hypertension results from the secretion into the blood of pressor substances elaborated by a kidney in which the blood flow has been diminished by ischemia. It is customary and still useful to regard renal hypertension as a compensatory mechanism brought into play to maintain glomerular filtration as the number of glomeruli is diminished by injury or disease.

Retinitis—Retinitis may occur in any form of chronic degeneration of the kidney which causes or is associated with marked hypertension. In the absence of hypertension retinal lesions are rare in renal disease. Albuminuric retinitis or as it is now generally termed *hypertensive neuro retinopathy* is essentially a complication of retinal arteriolar sclerosis which in turn is believed by many to result from prolonged arterial spasm. Although the pathological basis of albuminuric renal retinitis is an arteriolar sclerosis the ophthalmoscopic picture is distinct from that of a primary arteriosclerotic retinitis. Renal retinitis is chiefly characterised by oedema of the retina, papilloedema and cotton wool patches whereas in arteriosclerotic retinitis (retinopathy) the vascular changes predominate mainly in the form of deflection of the veins at the arterio venous crossings, irregularities in calibre, narrowing of the arteries and retinal hæmorrhages. It is distinguished from renal retinitis by the comparative absence of exudates which when present are small and appear as powdery white glistening discrete points without any suggestion of wooliness. Arteriosclerotic retinitis is moreover unilateral in over 50 per cent of cases. The prognosis in either form is bad. Life is usually not prolonged more than two years after the appearance of arteriosclerotic retinitis and rarely more than a few months in cases of renal retinitis. There are however exceptions in both instances and renal retinitis may even resolve.

CEDEMA

Dropsy though still a prominent symptom in many of the principal forms of Bright's disease does not dominate the clinical picture in civilised communities to the extent that it

did at the time Bright wrote his classical papers. It is still however, a prominent feature in nephritis occurring in under nourished races. From this it may be inferred that whatever the precise pathogenesis of œdema in nephritis its development is favoured by an underlying state of malnutrition and all that that may imply. Œdema in Bright's disease may be considered under three headings—cardiac nephritic and nephrotic, and its treatment is discussed in the appropriate sections (q r.)

Cardiac Œdema.—Cardiac œdema is of frequent occurrence in those forms of Bright's disease characterised by arterial hypertension, i.e., in primary granular kidney and in chronic glomerular nephritis. Heart failure in these conditions is a common event and is frequently the immediate cause of death. In some cases of acute nephritis the heart gives way in face of a sudden increase of blood pressure, and a cardiac œdema is superimposed upon a nephritic œdema. Cardiac œdema may generally be recognised by accompanying signs of back pressure such as dyspnoea, cyanosis, and enlargement of the liver, and by the appearance of œdema in the dependent parts. Cardiac œdema is essentially due to increase in the capillary blood pressure but the deficient circulation also injures the capillary wall as shown by the moderate increase in the protein content of the œdema fluid, which is generally about 0.5 per cent. Estimation of the blood cholesterol is sometimes of value in differentiating between a cardiac and a nephrotic œdema. An increase in the blood cholesterol (above about 220 mgm per 100 c.c.) is suggestive of the latter.

Nephritic Œdema.—Nephritic œdema is not primarily due to circulatory embarrassment and is less influenced by gravity. Posture therefore plays only a secondary part in its distribution. Nephritic œdema typically begins in the face, though later it may extend to the whole body. In many instances, however, in ambulatory cases, œdema is first noticed in the feet or ankles. The cause of nephritic œdema is believed to be an increased permeability of the capillaries throughout the body, which permits the escape of water and proteins into the tissue spaces. The protein content of the œdema fluid is therefore high, generally over 1.0 per cent.

Nephrotic Œdema.—Nephrotic œdema does not differ from nephritic œdema in its clinical characteristics or distribution. It is due to diminished colloid osmotic pressure of the plasma proteins caused mainly by continued loss of proteins into the urine. The protein content of the œdema fluid is low and generally under 0.1 per cent. It is met with in nephrosis, the nephrotic stage of glomerular nephritis and in amyloid disease.

of the kidney. It also occurs from diminution of the plasma proteins from extra renal causes, *i.e.*, without loss of protein in the urine, as from malnutrition in hunger œdema, and in the gross ascites of cirrhosis of the liver, in which large amounts of protein are withdrawn from the blood. It will be noted that of the three forms of œdema commonly met with in cases of renal disease, two, namely cardiac and nephritic œdema, are entirely extra renal in origin. Only one nephrotic œdema, is caused chiefly by renal disease. These three types of œdema may occur singly or combined so that the pathogenesis of the œdema in many cases of renal disease is often exceedingly complex.

URÆMIA

The term uræmia was originally used to describe the symptom complex, which was believed to result from the intoxication of blood imperfectly purified by the kidneys, in other words, poisoning with urine. At one time or another practically all the signs and symptoms of Bright's disease have been included under this term. With more precise knowledge of the nature of renal function, and with evidence that none of the known urinary constituents, either alone or together, is directly capable of reproducing any of the clinical manifestations of so called uræmia, the term is now restricted to that group of symptoms which directly and invariably accompany renal insufficiency. This clinical picture constitutes *true uræmia*. Those numerous symptoms which may also accompany renal insufficiency, but which *can also occur without it*, are now classified as *false or extra-renal uræmia*. True uræmia may be defined as the symptom complex accompanying retention of urinary constituents in the organism as a result of defective renal function. It will be observed that true uræmia cannot occur with normal renal function, whereas pseudo or extra renal uræmia can and does occur with perfectly normal renal function. Both true and false uræmia frequently occur together.

True Uræmia.—The symptoms of true uræmia are best seen when mechanical obstruction to the flow of urine is present, and in prolonged anuria. They are —

- 1 Mental and physical fatigue, weakness, drowsiness, and dullness which suggests narcosis. The physical fatigue may be extreme, quite intolerable and may dominate the whole clinical picture.

- 2 Facilitation phenomena involuntary coarse muscular contractions especially of extensor groups increased tendon and skin reflexes contraction of the pupils deep breathing and hiccoughs
- 3 Rapid loss of weight and emaciation
- 4 Alimentary disturbances such as anorexia vomiting and diarrhoea
- 5 Tendency to inflammation and necrosis pharyngitis, laryngitis stomatitis gastritis enteritis necrotic ulcers of the mouth stomach intestines and colon and often pericarditis
- 6 Urinary smell in the breath
- 7 Subnormal temperature
- 8 Cardiac irregularities—usually dropped beats sometimes preceding sudden death

Asthemia is the most constant symptom. It is important to realise that severe headache and convulsions are not a feature of true uræmia but of an accompanying pseudo uræmia.

Pseudo- or Extra-renal Uræmia—This is divided into two groups. Acute or Eclamptic Pseudo uræmia which is met with in acute and subchronic glomerulo nephritis and most typically in eclampsia of pregnancy and Chronic or Hypertensive Pseudo uræmia (hypertensive encephalopathy) of primary or secondary hypertension.

Eclamptic Uræmia—The chief manifestations are those of increased intracranial pressure both localised and generalised. Headache amaurosis vomiting bradycardia papilloedema and choked disc. Diminished abdominal and tendon reflexes and an extensor Babinski are not uncommon. Drowsiness may increase to coma with stertor or may pass into a series of convulsions. The convulsions are identical with those seen in epilepsy and may be generalised or unilateral. Maniacal excitement may replace or accompany the convulsions. The whole syndrome is due to cerebral oedema perhaps with disturbances of the cerebral circulation.

Hypertensive Pseudo uræmia—In its major form this variety of pseudo uræmia again simulates epilepsy very closely consisting of a prodromal stage followed by tonic and clonic convulsions and coma. The most usual prodromal symptoms are apathy restlessness headache anorexia vomiting and oliguria and sometimes localised paræsthesie. The blood pressure usually rises during this stage. In many cases the convulsions occur as a bolt from the blue. The actual convulsions are indistinguishable from those of idiopathic epilepsy. In addition to these purely cerebral symptoms paroxysmal

dyspnoea, Cheyne Stokes respiration, and retinal arteriosclerosis are also found. The paroxysmal dyspnoea is of two types (a) cardiac asthma which tends to result in pulmonary oedema, and (b) bulbar asthma, periodic or Cheyne-Stokes respiration.

It cannot be too strongly emphasised that there is no direct correlation between retention of urinary constituents and pseudo uræmia, both varieties of which may and do frequently occur with perfectly normal renal function.

Treatment of Uræmia—Since true uræmia results from loss of concentrating ability and no means of improving this directly (except in cases of urinary obstruction) are known treatment consists essentially in ensuring as far as is possible that the total quantity of waste products excreted by the kidney over a given period is correspondingly increased. This is achieved firstly by increasing the volume of the urine and secondly by diminishing the quantity of waste products to be eliminated—that is, by limiting the diet. Treatment should be controlled throughout by estimation of the blood urea every few days. Diuresis is promoted by increasing the total fluid consumption to 3, 4, or more pints per twenty four hours. If this does not suffice, the low protein and salt diet recommended on page 690 should be given in addition. Diaphoresis, purgation, and other measures for the extra renal elimination of water and waste products should be definitely avoided. The treatment of pseudo uræmia as met with in Bright's disease is considered on page 691.

BRIGHT'S DISEASE

In 1827 Dr Richard Bright of Guy's Hospital pointed out that coagulable urine and dropsy were often associated with disease of the kidneys. Thereafter such conditions were known as Bright's Disease. It later became apparent that many different pathological states were included under this heading which, however, it is convenient to retain as a comprehensive term to include certain non suppurative renal diseases.

Despite repeated attempts no completely satisfactory classification of the various forms of Bright's disease has yet been evolved. A simple and practical scheme is to divide them into three main groups as follows—

- (1) Nephritis
- (2) Nephrosis
- (3) Primary Nephrosclerosis

Nephritis (Syn. Acute and Chronic Diffuse Glomerular, or Glomerulo tubular Nephritis, Acute and Chronic Nephritis)

may be defined as a "bilateral non suppurative inflammatory disease of the kidneys (Osler), and occurs in four forms —

- (a) Diffuse glomerulo nephritis (acute and chronic)
- (b) Focal non-embolic glomerulo nephritis
- (c) Focal embolic glomerulo nephritis
- (d) Acute interstitial "nephritis"

DIFFUSE GLOMERULO NEPHRITIS

Diffuse glomerulo nephritis, as its name partly implies, is a diffuse bilateral non suppurative inflammation of the kidneys. In its most typical (though not most frequent) and complete form it is characterised by three stages. Acute, Subacute, and Chronic. Many cases clear up entirely after the acute stage becomes arrested, whilst in others the acute stage is so mild that it may never have been recognised, the case presenting itself for the first time with well marked signs and symptoms of the chronic stage commonly known as Chronic (Glomerular) Nephritis. So indefinite may be the connection between the acute and chronic stages, and so different their symptomatology and clinical course, that for long they were regarded as distinct diseases, and even now it is more convenient to describe them under the separate headings of Acute and Chronic Glomerulo nephritis.

ACUTE GLOMERULO NEPHRITIS

(ACUTE NEPHRITIS)

This form of nephritis probably always results from a previous infection elsewhere in the body, though cold and exposure are devitalising and therefore predisposing causes. It is the variety of nephritis which was known during the war of 1914-18 as trench nephritis. In some 80 per cent of cases in civilians it follows a streptococcal infection of the tonsils or other parts of the upper respiratory tract, its incidence is therefore greatest in childhood at which period such infections are rife. In former times scarlet fever was the most common cause of acute nephritis, but of recent years the incidence and severity of this disease has much diminished, and it now accounts for only a very small proportion of the total number of cases of acute nephritis. Other infections, such as pyoderma, pneumonia, infected wounds, malaria, and influenza, are

occasional causes of acute nephritis. In view of the importance of streptococcal infections in its aetiology it is curiously rare in erysipelas. Acute nephritis (diffuse form) also sometimes accompanies rheumatic fever, purpura and subacute bacterial endocarditis.

Age Incidence—The age incidence of acute nephritis is that of the primary infection and as sore throats and other infections of the upper respiratory tract are the most frequent causes most cases occur in childhood and early adolescence.

Sex Incidence—At all ages acute nephritis is more common in males roughly in the proportion of three to two and this is attributed to the greater likelihood of exposure. There is evidence that of recent years this disparity in the sex distribution is becoming less marked.

Familial Incidence—Acute nephritis occurring in several members of a family either simultaneously or at intervals is not very uncommon but it is doubtful how far this is coincidence and how far it is due to a familial predisposition.

Epidemics—Epidemics of acute nephritis were observed during the American Civil War, the Great War, the influenza epidemic of 1929 and post scarlatinal glomerulo nephritis is more common in some years than in others.

Exposure and Chill—Exposure and chill especially associated with a wetting have long been regarded as important causes of acute nephritis. There is little doubt that they act as predisposing causes of infection and in this manner give rise to acute nephritis.

Morbid Anatomy—The kidneys are usually normal in size or large, soft, congested and drip blood—the blood dripping kidney. The capsule strips easily. On section there is good differentiation between cortex and medulla and the glomeruli may stand out as pale greyish or dark red points. *Microscopically* the initial lesion is an endocapillaritis of the capillary loops of the glomeruli which are swollen, occluded and empty of blood. This is followed by proliferation of the endothelium of the loops and the appearance of numerous polymuclear leucocytes within the glomerulus and the whole tuft becomes enlarged. The walls of the glomerular loops undergo hyaline degeneration, individual loops often fusing. Albuminous exudate and red cells escape into the capsular space. It is important to note that all or almost all of the glomeruli are involved. The cells of the tubules in this stage often show little change or slight cloudy swelling or fatty degeneration. The lumen of the tubules may contain blood, albumen and

casts. The arteries also often show little change at first though later a necrotising arterioitis of the afferent arterioles and thrombosis may sometimes be found. In cases which do not resolve, thickening and hyalinisation of the glomerular loops occur after a few weeks or months and the capsular epithelium proliferates, forming the characteristic "epithelial crescents". It will be observed that the fundamental lesion in the kidneys in acute nephritis is a diffuse endocapillaritis; i.e. it is primarily a disease of the vascular system.

Pathogenesis—The renal lesions in acute nephritis are not due to the presence of the infecting organism in the kidneys, for they are rarely found there but to the injury set up by circulating toxins. This injury, however, is not a direct one due to bacterial toxins for nephritis does not generally arise until some time after the initial infection and more often than not during convalescence, i.e., long after the concentration of circulating bacterial toxins has diminished. This latent interval is of much importance in a consideration of the pathogenesis of the disease. In analogy with the latent interval in serum sickness, and because of other evidence both clinical and experimental it is thought that the renal lesions are due to a hyper-sensitive state developed during the acquisition of immunity. For example acute diffuse glomerulo nephritis frequently occurs in the course of subacute bacterial endocarditis not during the active septicæmic stage, but later during a bacteria free stage. This constitutes the "allergic" theory of the pathogenesis of acute nephritis. Another theory is that acute nephritis is but the local manifestation of a generalised capillary disease. This is supported by the fact that œdema frequently occurs so early and may precede the albuminuria, and that the high protein content of the œdema fluid suggests injury and increased permeability of the capillaries all over the body. Finally microscopical examination of the capillaries of the nail bed in acute nephritis has shown tortuosity and thickening of these vessels. Volhard interprets the ischæmia of the afferent glomerular capillaries in the early stages of acute nephritis as evidence of local vascular spasm, and regards the hypertension, narrowing of the retinal vessels, and pallor of the skin as evidence of a generalised vascular spasm (Volhard's Angio Spastic Theory). Hypertension, however, is not invariably present, nor are the capillary loops always completely devoid of blood. The view now mostly held is that the characteristic changes in the kidney and in the arterioles throughout the body in acute diffuse glomerulo nephritis represent the reaction of these tissues to the overproduction

of immune bodies which constitute the noxious agents or "toxins" concerned

Clinical Picture.—The clinical picture and course are extremely varied. The urinary changes, cardio vascular signs, or œdema, may dominate the picture, alone or in any combination, either throughout or at different stages of the disease. The signs and symptoms of the primary infection may also coincide at the outset and may predominate. The course, too, is varied and may be rapid or slow. The onset likewise may be sudden or insidious. Fulminating cases also occur. Often there is a latent interval between the primary infection and the appearance of signs and symptoms of nephritis. Hæmaturia and œdema are usually the first clinical signs, but either may occur alone or precede the other by some days. Puffiness of the eyelids in the morning is a common initial symptom and is often followed by swelling of the feet, legs, and external genitalia in the course of a few days. The urine may be bloody and scanty and there may be frequency, urgency, and lumbar pain or aching. Vomiting and abdominal pain with high temperature are common in children and occasionally in them the attack begins with acute cerebral symptoms, such as headache and convulsions. In some instances the onset is insidious. There is no obvious hæmaturia but some swelling of the ankles is noticed, perhaps after a walk, which later increases and spreads to other parts of the body. In more severe cases the œdema becomes generalised and involves the serous cavities, the lungs, alimentary canal, causing vomiting and diarrhoea, and the brain, resulting in the acute cerebral phenomena known as "eclamptic" uræmia. Urinary abnormalities, perhaps discovered on routine examination, may constitute the whole picture, but usually frank hæmaturia occurs at the outset and then diminishes in quantity, the urine assuming a smoky tint and finally becoming normal in appearance. Red blood cells, however, persist on microscopic examination for weeks or months after the urine appears normal to the naked eye. Albuminuria is constantly present throughout the course of the disease, and varies considerably in quantity, which, however, is only roughly proportional to the severity of the condition. The volume of urine is always diminished at the outset and may only amount to a few ounces in the twenty four hours. This oliguria is, however, chiefly extra renal in origin and the specific gravity is usually high. A low volume, with a low specific gravity, means severe impairment of renal function and the prognosis is grave. Complete anuria at the onset, and continued for more than three or four days, is of bad omen,

though it does not necessarily indicate a fatal issue. In the early stages the urine is nearly always very acid and diminishing acidity indicates a commencing diuresis and is a favourable sign. Casts of all kinds including blood and epithelial casts are present in the early stages. They vary considerably in number from time to time, and if much blood is present diligent search may be required to find them. In the majority of cases the blood pressure is increased at least in the early stages. In mild cases however there may be no hypertension. As a rule the blood pressure becomes normal in the course of two or three weeks and before the other manifestations of the disease have disappeared. It is not sufficiently realised that the heart is almost invariably affected even in mild cases. Modern methods show enlargement of the heart in the earliest stages due partly to acute left ventricular dilatation and slight hydropericardium. Left ventricular hypertrophy may appear in from four to five weeks. Bradycardia sometimes develops. In other cases mild myocardial insufficiency is shown by tachycardia, palpitations, dyspnoea and inability to lie on the left side. Death from sudden heart failure especially in children is not exceedingly rare and may be quite unexpected. In other cases there is a rapid failure following a convulsion or attack of vomiting with acute pulmonary oedema, cyanosis and orthopnoea. Hypertensive encephalopathy may develop at any stage during which the blood pressure is elevated though it is rare at the onset. Convulsions are less common now than formerly when copious fluids were given and death in a single attack is very rare. The prognosis when convulsive attacks are repeated at short intervals is grave. Recovery from a single attack of convulsions especially at the outset however is often followed by unexpected improvement in the further course of the disease. Renal function is often quite normal even in severe cases with gross oedema and marked hypertension. Death from true uraemia is a rare event in the early stages and generally renal function does not become seriously impaired until the case enters the sub chronic or chronic stages. The nitrogen retention which is so often found in the early stages is chiefly extra renal in origin and estimations of the blood urea at this stage are of little value. The blood count is generally normal and despite the pallor, anaemia is rare in the early stages. Frank retinitis is rare but some narrowing of the retinal vessels, and small retinal haemorrhages are not uncommon. During the formation of oedema the skin may be unusually dry.

Diagnosis—The only conditions likely to cause difficulty in

diagnosis are an acute exacerbation of a chronic nephritis, focal nephritis, and subacute bacterial endocarditis. Gross enlargement of the heart in the absence of symptoms of heart failure suggests an acute exacerbation of an underlying chronic nephritis. Edema, hypertension, or impairment of renal function, are inconsistent with a diagnosis of either focal nephritis or the glomerular embolisation of subacute bacterial endocarditis.

Course and Prognosis—Some 60 per cent of all cases recover completely in the course of a few weeks or months, the majority in six to eight weeks from the onset. The longer recovery is delayed the less likely is it to be complete though even after five or ten years, with persistent but mild urinary signs eventual recovery is not very uncommon. Some 40 per cent do not recover within two or three months of the onset, about 12 per cent passing into the stage known as chronic glomerulo nephritis. 11 per cent progress to a form of chronic nephritis with azotæmia but without hypertension, sometimes referred to as 'aplastic Bright's disease', 10 per cent develop persistent hypertension without other signs of renal disease and 7 per cent continue to pass large quantities of albumen in the urine indefinitely without other signs of nephritis, a condition known as 'leaky kidney'. Death during the acute stage is rare, and occurs in less than 5 per cent of cases. The tendency to chronicity is greater in the nephritis following tonsillitis and other infections than in post scarlatinal nephritis. Acute nephritis developing after the active stage of subacute bacterial endocarditis generally becomes chronic. In all cases of acute nephritis extreme oliguria is dangerous and anuria persisting for more than four days is often fatal. Acute myocardial failure with pulmonary oedema is the most common cause of death, and pneumonia and hypertensive encephalopathy are the next most common. Single convulsions at the outset do not render the prognosis worse but frequently repeated convulsions are often fatal. The amount of oedema, hæmaturia or albuminuria, bear no relation to the immediate or ultimate prognosis, indeed, it may be said that, especially in children the more bloody the urine the better the outlook. The chances of complete recovery, however are inversely proportional to the length of time required for any one of these symptoms to abate. This is particularly true with regard to hypertension, though, of course, hypertension may be entirely absent in some cases which die from uræmia. True uræmia however is a comparatively rare cause of death in acute nephritis.

TREATMENT OF ACUTE DIFFUSE GLOMERULO-NEPHRITIS

Prophylaxis.—Despite the frequency with which acute nephritis follows streptococcal tonsillitis, its incidence is as high in those who have previously had their tonsils removed as in those in whom this operation has not been performed. It is evidently impossible to remove completely the source of sepsis which embraces the whole of the lymphatic ring. Tonsillectomy, therefore, is useless as a prophylactic measure. Neither is there evidence that the early use of anti scarlatinal serum, in cases of scarlet fever, reduces the incidence of post-scarlatinal nephritis. The only measures known to diminish the incidence of post scarlatinal nephritis are prolonged confinement to bed, combined with the administration of sufficient alkali by mouth (Pot Cit and Sod Bic in equal parts) to render the urine persistently as alkaline as, or a little more alkaline than, the blood, i.e., pH =greater than 7.4. It is possible that similar measures applied to patients with tonsillitis would result also in diminishing the incidence of post tonsillitic nephritis, but, unfortunately, this is not always practicable. Sulphonamide therapy has not as yet been proved to diminish the incidence of acute nephritis as a complication of acute infections.

General Management—Strict confinement to bed is imperative in the earlier stages. Avoidance of chill is important and flannel garments only should be worn. The fluid intake and urinary volume should be accurately measured and recorded every twenty four hours, together with an estimation of the specific gravity of a sample of the twenty four hours' urine. Methods of producing profuse sweating, such as hot air baths, hot packs, and the injection of pilocarpine, are best avoided. No purges of any kind should ever be given. Regular action of the bowels should be maintained by simple lubricants such as liquid paraffin or soap and water enemata.

Dietary.—In early and severe cases absolute starvation, as recommended for some years by Volhard, i.e., no fluids and no solids, should be enforced for three or four days. Experience has shown that patients suffer surprisingly little discomfort under this drastic treatment if a little orange juice be given to moisten the mouth. In less severe cases half a glass of lemonade with added glucose is given three daily, and half an orange night and morning. After the first three days this is increased to a pint of lemonade or orange juice *per diem*, with added glucose and some cooked fruit. Thereafter the fluid intake is regulated to correspond with the previous

twenty four hour volume of urine, and solids are given as follows —

Early morning—sweetened drink

Breakfast—fruit, cooked or raw

Lunch—potatoes with *fresh* butter, compote of fruit

4 P M —fruit, cooked or raw

Dinner—same as lunch

This diet is a considerable aid to lessening hypertension, œdema, albuminuria, and especially hæmaturia. It is an adequate maintenance diet, albeit dull, for a patient confined to bed and should be continued if possible until any or all of the aforementioned symptoms have abated and show no further daily improvement. Thereafter the diet should gradually be increased by the addition of substances having the lowest sodium content—eggs, boiled fish chicken, etc. It will be noted that neither milk nor bread are included in this diet. Return to a full diet must depend on the patient's subsequent progress, but should not be unduly delayed.

Drugs—No diuretics of any kind should ever be used in the early stages of acute nephritis, though potassium citrate, in doses sufficient to render the urine persistently alkaline, is a valuable aid to recovery if used at the right time. It should never be given in the presence of macroscopic hæmaturia, but should be exhibited as soon as the urine becomes free from blood to the naked eye.

Surgical Treatment.—Decapsulation is sometimes practised for persistent anuria. There is no satisfactory evidence that it does good and the operation is rightly falling into disuse. A more rational procedure is to block the lumbo sacral nerve roots by means of spinal anaesthesia. Generally, little can be done in this stage, but the intravenous injection of hypertonic solutions (30 c.c. of 30 per cent NaCl or 30 c.c. of 50 per cent glucose) may be tried, in addition, of course, to local measures such as hot poultices over the loins. Tonsillectomy should never be carried out during the early stages of acute nephritis, and rarely even later with the object of improving the renal condition or preventing relapses or progression to the chronic stage. The results of tonsillectomy, on the subsequent course of acute nephritis are definitely disappointing. Operations designed to relieve sinus infections are also generally of little benefit to the renal condition.

Treatment of Special Symptoms—The blood pressure should be taken at least three weekly in all cases, owing to the danger of comparatively sudden cardiac failure. Should this seem imminent, immediate venesection should be practised. The

months others do not. They pass through various stages referred to by clinicians as subacute sub chronic or chronic glomerulo nephritis and by pathologists as large white kidney, and small white secondary contracted or granular kidney. Confusion was inevitable and long obscured the simple issue that these were merely different stages in a single pathological process and not distinct varieties of Bright's disease. The terminal stage in which the essential renal elements are mainly replaced by fibrous tissue was also confused with and included under the term chronic interstitial nephritis now only applied to the kidney of essential hypertension (primary granular kidney or small red kidney). Confusion was made worse because in many cases a protracted stage was reached in which gross oedema dominated the picture to such an extent that on clinical grounds true nephrosis was exactly simulated. In the absence of any clear history of a preceding acute nephritis and knowledge of what the outcome would be such cases were either described as chronic nephrosis or its synonym chronic parenchymatous nephritis. The terms subacute and sub chronic have been used indiscriminately to describe any case of acute nephritis whatever the signs in which the course was so prolonged that eventual recovery seemed unlikely. It is now known however that not a few patients recover completely, even though abnormalities persist in the urine for several years. It would seem more logical therefore to regard such cases as examples of unresolved acute nephritis until complete recovery takes place or signs and symptoms develop such as *persistent* hypertension or azotemia which are known never or rarely to remit. In the former event the term chronic nephritis may properly be used it being by common consent only employed to describe a progressive and ultimately fatal condition. It is true that a large number of patients present themselves for the first time with unmistakable signs of chronic glomerulo nephritis in whom there is no history of any previous attack of acute nephritis nor of having passed through the intermediate stages which typically precede the development of the final stage here described as chronic glomerulo nephritis. It is known however that acute nephritis quite commonly occurs in or follows many infections in a form so mild that it can only be discovered by careful routine examination of the urine and thus is seldom done. It is also known that in some of these mild cases there is a latent interval (latent stage of acute nephritis) of many years in which the usual manifestations of progressive renal disease are apparently absent and yet ultimately the complete

picture of chronic glomerulo nephritis develops in a manner so insidious that its origin cannot be determined. The present day view is that acute glomerulo nephritis either clears up altogether or develops into chronic glomerulo nephritis and that the latter is the only form of Bright's disease to which the term *chronic nephritis* can strictly be applied.

Ætiology and Occurrence.—The causes of chronic glomerulo nephritis are those of acute glomerulo nephritis from which it arises. The factors determining which cases become chronic are unknown. Chronic nephritis would seem to be more likely to follow tonsillitis than scarlet fever. Acute cases, with an insidious onset without a definite preceding infection, and those chiefly characterised by oedema without gross hæmaturia as an initial symptom are also more liable to become chronic. Macroscopic hæmaturia persisting undiminished for more than about six weeks is also a bad prognostic sign with regard to chronicity. On the other hand, the tendency to become chronic is not related to the severity of the acute attack. The age at the onset of the acute attack, however, does exert an influence on the liability to chronicity, which is more marked in older subjects, except in the aged, when the acute disease is said to run a particularly benign course. Chronic nephritis occurs at all ages, but chiefly in early life, and under thirty five years of age. It is more prevalent in the male sex, as is the acute disease.

Pathological Anatomy—Macroscopically, the kidneys in chronic glomerulo nephritis fall into two groups, the large and the small kidneys. The former are found in the first few months or years of the disease and are known as the "large white kidney." the latter is the final stage in which much of the renal tissue is replaced by fibrous tissue which contracts and the whole organ shrinks and becomes smaller than normal. Intermediate forms are numerous. The large white kidney, corresponding to what was formerly called by clinicians chronic nephrosis or later subacute nephritis, is a large pale kidney, soft and often congested. The capsule strips easily, and on section the cortex is wide and differentiation from the medulla is well marked. The cut surface is pale and greasy and flecked with yellow areas of pseudo fatty or lipid degeneration (so-called mælin kidney). The small granular kidney (small white kidney, secondary contracted kidney), on the other hand, is hard and granular, with thickened capsule which does not strip readily. The granulations are fine and of a pale yellowish colour, which contrasts with the darker coloured shrunken areas surrounding them. On section the cortex is narrow and

irregular, and large areas of fibrosis and lipoid degeneration occur. Demarcation from the medulla is poor. The vessels are markedly thickened. There is an increase of the peripelvic fat.

Microscopic Appearances—In the earlier stages, that of the "large white kidney," the glomeruli are enlarged from proliferation of the capillary and capsular epithelium which takes the form of the so called epithelial crescents. Fahr describes two groups one in which the main glomerular changes are intra-capillary, *intra capillary nephritis*, and the other in which capsular proliferation is the more prominent, *extra-capillary nephritis*. The latter is considered to run a shorter course. Many of the glomeruli undergo hyaline degeneration, and the capsular epithelium becomes replaced by fibrous tissue. The tubules undergo hyaline fatty and lipoid degeneration, the tubular epithelium desquamates and the tubules atrophy and collapse. Attempts at tubular regeneration are also found together with areas of dilated tubules serving hypertrophied glomeruli. There is marked proliferation of the interstitial connective tissue. Arteriolar lesions are prominent and consist of necrotising arteriolitis, obliterative endarteritis, medial hypertrophy, and arteriosclerosis. The medial hypertrophy serves to distinguish chronic glomerulo nephritis from primary granular kidney, in which the initial vascular lesion is an intimal hyperplasia. In the later stages (secondary contracted kidney) the histological picture is an advanced stage of that just described, in which hyalinisation and fibrosis of glomeruli, atrophy of tubules, and increase of the interstitial tissue reach enormous proportions. Evidence of epithelial proliferation is lost or is confined to small scattered areas.

Clinical Picture of Chronic Glomerulo-Nephritis—In a disease which passes through so many varied stages it is difficult to give a comprehensive description. It must be borne in mind that not every patient passes through these stages consecutively.

Subacute Type—This is sometimes known as Subacute Nephritis. It comprises those cases of acute nephritis in which the major symptoms such as hypertension, azotemia, cedema, do not remit but steadily progress over a period of weeks or months to a fatal termination from heart failure, uræmia or pneumonia.

Nephrotic Type—This was formerly known as Chronic Nephrosis or Chronic Parenchymatous Nephritis and was regarded as a distinct variety of Bright's disease. The chief symptoms are gross cedema and albuminuria without hypertension or azotemia and this stage may last for many months,

or even several years, during which time it may be indistinguishable clinically or biochemically from true chronic nephrosis. A few patients recover completely, but more often either death occurs from some intercurrent infection or the oedema gradually subsides, leaving a persistent albuminuria as the only remaining sign of renal disease. After months or years, however, the blood pressure gradually rises and impairment of renal function occurs, and the patient passes into the final stage of secondary contracted kidney. Often this is reached whilst oedema is still present, and there is no intermediate period characterised by persistent albuminuria only. Such cases are known as 'mixed nephritis'.

Hypertensive Type—In some instances of acute nephritis (approximately 10 per cent in war nephritis) all signs of renal disease disappear in the course of a few weeks or months except the hypertension, which persists indefinitely. The prognosis is that of pure essential hypertension, with ultimate death from cardiac defeat, cerebral hæmorrhage, and in a few cases uræmia. It is worthy of note that this type of after result is more often found when the acute nephritis is contracted in adult life though it may sometimes be met with in children. It is the liability to this form of response which renders the prognosis of acute nephritis less favourable, on the whole, in adults than in children.

Recurrent Type—The patient apparently has repeated attacks of acute nephritis but in the intervals albuminuria is always present and often microscopical hæmaturia. Eventually the blood pressure rises renal function becomes impaired, and death occurs from heart failure and uræmia.

'Leaky Kidney' Type—In some cases of acute nephritis all signs of renal disease disappear, with the exception of albumen in the urine which persists for many years in considerable amounts. Some of these patients ultimately develop hypertension and azotæmia and die from chronic nephritis while others lead active lives for twenty or more years apparently none the worse for the albuminuria.

Onset—There may be a clear history of an attack of acute nephritis and the patient may present himself in any of the stages just described having either been entirely free from signs or symptoms or having been continuously ill since the onset of the acute attack. Others have no knowledge of any previous acute nephritis and attend for one or more of the most prominent symptoms of the various stages described—headaches, oedema, asthenia, anorexia, polyuria, dysuria, epistaxis, failing vision or blindness. Frequently the disease

is first discovered on routine examination for life insurance or other reasons

Chief Signs and Symptoms—**Oedema** is often entirely absent both in the acute and chronic stages of glomerulo nephritis. In the majority, however it is present at some time. In the nephrotic stage it is the most prominent feature and effusions into the serous cavities are common. Nephrotic oedema which is due to capillary damage is present in the earlier stages of glomerulo nephritis only and is characterised by the high protein content of the oedema fluid without much reduction of the protein content of the blood. Usually it requires some months for enough protein to be lost in the urine to reduce the blood proteins sufficiently for the production of nephrotic oedema which is characterised by its very low protein content.

Hypertension—It cannot be too strongly emphasised that hypertension is not an invariable symptom of chronic nephritis. Many cases run their complete course and terminate in uræmia without hypertension. It is however a very common symptom and frequently dominates the clinical picture and when present largely determines the prognosis. In such cases death from gradual myocardial failure often occurs and may be foretold by a progressive fall in the blood pressure over a period of weeks or months. Indeed in chronic nephritis a falling blood pressure is often a most unfavourable sign. In addition to myocardial failure hypertension gives rise to many of the signs and symptoms formerly included under the term uræmia such as violent headaches convulsions amaurosis retinitis and hypertensive encephalopathy in general. Cerebral hæmorrhage is not so common in chronic nephritis (under 20 per cent) as in essential hypertension probably because the age incidence of the former is in general some ten years lower than in the latter, and arteriosclerosis of the cerebral vessels has had less time to appear.

Uræmia—Paradoxically, death from uncomplicated true uræmia is not very common in chronic nephritis. More often cardio vascular and extra renal factors are added to an underlying but not lethal true uræmia and precipitate a fatal issue. Some cases remain in the stage of compensated impairment of renal function for years but once impairment of function occurs it does not improve.

Anæmia—A secondary anæmia with low colour index is exceedingly common and may be very severe. As a rule the anæmia does not appear until renal function becomes impaired and is roughly parallel to the degree of impairment and may in turn cause further loss of function through insufficient

oxygenation of the renal cells. If purpura occurs the platelet count is usually normal.

The Urine—Albuminuria is almost constantly present in chronic glomerulo nephritis. In the nephrotic stage very large quantities may be found. In the stage of contracted kidney albuminuria is less and at times there may be only a trace or even none. Whereas diminution in the amount of albumen passed in the urine is generally a favourable sign in chronic nephritis the reverse is often the case when it marks the onset of the stage of contracted kidney and especially when it accompanies and is a result of increasing impairment of renal function. Casts of many kinds epithelial, fatty, granular, and hyaline are also frequently present in the urine in chronic nephritis. In the nephrotic stage they may be very abundant and many show doubly refractile particles. In the terminal contracted kidney stage they become fewer in number and may often be absent or represented by an occasional hyaline cast. Macroscopic hæmaturia is not a common feature of chronic nephritis except during acute exacerbations. Red cells however are constantly found on microscopical examination throughout the disease except in the nephrotic stage in which they may practically disappear and so render differentiation from chronic nephrosis difficult.

Diagnosis—In a typical case the diagnosis presents no difficulty but where single symptoms are so marked as to dominate the clinical picture diagnosis may not be easy and this is especially true when there is no history of a preceding attack of acute nephritis. In children and adolescents in whom albuminuria is the only abnormal feature the diagnosis has to be made from the benign albuminurias described above (vide p. 671). The nephrotic stage of glomerulo nephritis may simulate true chronic nephrosis so completely that an exact diagnosis may never be possible. However true nephrosis is a rare disease especially in adults and most examples of this syndrome eventually prove to be chronic glomerulo nephritis. Hypertension with slight albuminuria may cause confusion with essential hypertension with commencing renal involvement. The differential diagnosis is often impossible but it should be borne in mind that glomerulo nephritis most often occurs under thirty years of age and essential hypertension over this age. Polycystic disease of the kidneys may simulate glomerulo nephritis, but the kidneys are generally obviously enlarged and characteristic changes are found in the renal pelvis with the aid of a pyelogram. The diagnosis from long standing pyelonephritis is often completely impossible though here also

pyelograms may assist. Anæmia may be so profound in glomerulo nephritis as to suggest at first sight pernicious anæmia or leukaemia. It should be remembered in this connection too, that uræmia is the most frequent cause of "idiopathic" purpura in adults. Myxœdema also may superficially resemble chronic nephritis.

Prognosis—Chronic nephritis is ultimately fatal. The only point to be decided about the prognosis of chronic glomerulo nephritis is the rapidity of the process and in this two factors play the dominant role—cardio vascular complications and impairment of renal function. With either or both of these factors present life may continue for several years but once symptoms arise from either a fatal issue is to be expected generally within a few months. In all cases and at all stages especially during the nephrotic stage intercurrent infections constitute a grave danger.

Treatment—The general tendency in the past has been to over treat especially as regards dietetic restrictions in the earlier stages and to be too despondent and lax in the later stages when more urgent symptoms are present.

Regime—With one exception strict confinement to bed is essential for a period when the patient first comes under observation. The duration of this period of bed rest depends upon the severity and rate of progress of the disease and the response to treatment. As a general rule confinement to bed should continue until it is fairly certain that no single sign or symptom is likely to improve further whether this period be one of weeks or months. The process of getting the patient up must always be effected slowly, and graded by the use of the couch chair and walking successively. An increase or return of any sign or symptom lasting for more than forty eight hours indicates a return to the previous stage of rest for a time and then a re trial. The exception is elderly patients suffering from marked renal insufficiency which is known to be of long duration and who have been ambulant. These should not suddenly be confined to bed as they have often become attuned to their state and are unable to readjust themselves rapidly to new conditions.

Diet—The correct diet for patients with chronic nephritis depends chiefly upon renal function. It is therefore essential that renal function tests should be performed at intervals of not less than two to three months throughout the entire course of the disease. So long as renal function remains normal and there is no macroscopic hæmaturia there is no contraindication to a full allowance of protein in the diet.

whatever other symptoms may be present including hypertension. There is no evidence that one form of protein is more injurious than another, and red meat is as harmless as so-called white meat, such as fish or chicken. During the compensated stage of impaired renal function there is likewise no need for protein restriction but as soon as decompensation occurs as shown by an increase in the blood urea the total quantity of protein must be diminished. Even then it is generally possible and desirable to permit meat at least once a day. Under no circumstances must the protein intake be allowed to fall below 1 gram per kilogramme of body weight per diem except in emergencies such as an acute exacerbation or in advanced renal insufficiency and then not for a longer period than ten to fourteen days. Prolonged protein deprivation leads to anæmia with further diminution of renal function and increased endogenous protein katabolism. In the nephrotic stage, provided renal function is intact a full protein diet should be given sufficient to cover in addition the daily loss of protein in the urine.

Salt Intake—Restriction of salt should be imposed (a) when œdema is a prominent feature, (b) with cerebral or cardiac symptoms resulting from marked hypertension and (c) with prolonged macroscopic hæmaturia. It is generally sufficient to omit added salt but to allow that used in cooking, except in the treatment of hæmaturia when an absolute salt free diet is important.

Fluid Intake—When impairment of renal function and œdema coexist the former must take precedence in treatment and the fluid intake should be increased to that which will produce the maximum volume of urine even at the risk of increasing the œdema. If, as a result of increasing the fluid intake the urinary volume is not augmented then diuretics must be employed in addition. When renal function is normal as it usually is when œdema is a marked feature, the fluid intake should be restricted, but to not much less than the volume of urine for the preceding twenty four hours, and never to the point of inducing thirst.

Drugs—No drugs are known which improve renal function and it is only as auxiliary agents that they are of value in chronic nephritis. Digitalis should be used in myocardial failure whether hypertension is present or not. As in acute nephritis, diuretics should not be used as a routine in the presence of macroscopic hæmaturia. They should be employed as an aid to inducing polyuria as mentioned above, and for this purpose potassium citrate by mouth is the most useful.

They may also be used in the treatment of oedema in the nephrotic stage as described under the treatment of nephrosis (rule p 709). Mercurial diuretics, such as salyrgan, are contra-indicated. Iron may be given, as iron and ammonium citrate (90 to 120 gr per diem), for anaemia, and occasionally blood transfusion is required in extreme emergencies, but the danger of subsequent anuria is very great even with careful grouping. For violent headaches which do not respond to low salt diet, hypertonic magnesium sulphate (5 per cent solution) may be given rectally twice daily, or nitrites bromides, barbiturates, or morphine may be given. Venesection followed by lumbar puncture is however, often more effective. The fluid balance in the body, and particularly the volume of urine excreted, should never be upset by the giving of purges. Only liquid paraffin or simple enemata should be given. For similar reasons, diaphoresis is undesirable. Large quantities of fluids of any kind should never be given intravenously.

Surgical Treatment—Infective foci, such as septic tonsils, sinuses, and teeth, are generally better left untouched, but acute conditions, such as mastoiditis or appendicitis, must be dealt with surgically. Decapsulation is sometimes recommended for the nephrotic stage of chronic glomerulo nephritis. The results are disappointing, and the proportion of recoveries is far less than the occasional spontaneous 'cures'.

FOCAL (NON EMBOLIC) GLOMERULO NEPHRITIS

This variety of acute glomerulo nephritis was first described by Vollhard and Fahr in 1914. It occurs chiefly in children suffering from various acute infections, notably streptococcal tonsillitis, a mastoiditis, and less often pneumonia, scarlet fever, typhoid, erysipelas malaria, measles, rheumatic fever, and some forms of purpura. In contrast with acute diffuse glomerulo nephritis, however, it tends to occur *at the height of the primary infection* and not after a latent interval, as in the diffuse variety. Further, the causal organism may be found in the kidney and in the urine, in which respect it again differs from the diffuse form of the disease. Whereas diffuse glomerulo nephritis would seem to be due at least indirectly, to the effects of circulating toxins produced outside the kidney, focal nephritis apparently arises during attempts at excreting the causal organism itself. Pathologically the essential lesion is an acute glomerulitis affecting only comparatively few glomeruli and only *individual loops* of a single tuft. From the nature of the essential lesion it is clear that neither hypertension,

azotæmia nor œdema occur. Clinically the cases are characterised by sudden and often profuse hæmaturia occurring at the height of the primary infection, absence of œdema, hypertension and diminution of renal function. The hæmaturia often clears suddenly in the course of a few days but in some cases a few red cells may persist in the urine for months or years. Albumen is present but is not in excess of the amount of blood. Casts of all kinds may also appear at the outset. The prognosis is almost invariably favourable except in very rare instances in which frequently repeated attacks ultimately lead to the destruction of a sufficient number of nephrons to cause impairment of renal function. The treatment is that of the primary infection, no special measures being required for the renal condition. Recurrent attacks are sometimes prevented by surgical removal of the original focus of sepsis. There is much evidence that this is the only form of nephritis in which removal of septic foci can justifiably be recommended for its beneficial results *on the renal lesion*. It is unfortunate that removal of focal sepsis should only be of much value in that form of nephritis which in any event has a completely satisfactory prognosis. When surgical intervention is undertaken it should be delayed until many weeks after macroscopic hæmaturia has subsided.

LOCAL EMBOLIC GLOMERULO NEPHRITIS

(Multiple Glomerular Embolisation)

This variety of acute nephritis occurs only during the active (bacteræmic) stage of subacute bacterial endocarditis in which it causes repeated transient attacks of hæmaturia without œdema, hypertension or azotæmia. Bacterial emboli are lodged in the glomerular tufts. It is quite distinct from the non-embolic diffuse glomerulo nephritis which so frequently complicates the later inactive (non bacteræmic) stages of subacute bacterial endocarditis and leads to progressive renal insufficiency and death from uræmia.

ACUTE INTERSTITIAL NEPHRITIS

This comparatively rare condition gives no indication of its presence during life and is really not a form of nephritis at all in that the nephrons are not affected although it is customary to describe it under this name. Microscopically the essential lesion is a focal infiltration of the interstitium of the kidney

with lymphocytes. It does not give rise to symptoms. It occurs chiefly in children in the course of very severe and fatal streptococcal infections such as tonsillitis, scarlet fever, and septicæmia.

THE NEPHROSES

The word nephrosis was introduced by Mueller in 1905 to distinguish the primary degenerative from the primary inflammatory nephropathies. Nephrosis may be defined as a *primary non-inflammatory degeneration of the renal parenchyma (tubules)* and therefore includes a large variety of pathological changes and their clinical counterparts ranging from a transient cloudy swelling of the cells of the tubules as in febrile albuminuria to the most extreme lipid degeneration of these cells as in chronic lipid nephrosis. For convenience and because of the clinical similarity to some of the true nephroses it is also customary to include in the term nephrosis such disorders as amyloid disease of the kidneys, some forms of pregnancy kidney and other conditions of rather uncertain pathology. These may be referred to as pseudo nephroses to distinguish them from the true nephroses. Some authorities restrict the term nephrosis entirely to chronic cases, the chief pathological change in which is a lipid infiltration of the tubular epithelium, but it would seem generally more convenient to adopt the wider definition given above and to classify the main sub-varieties in some such manner as follows—

True nephrosis	{	1 Larval
		2 Necrotising
		3 Acute
		4 Chronic
Pseudo nephrosis	{	1 Amyloid
		2 Pregnancy

LARVAL NEPHROSIS

This is characterised clinically by albuminuria and pathologically by cloudy swelling and sometimes fatty degeneration of the cells of the renal tubules. Under this heading are included the febrile albuminurias and the albuminuria of pulmonary tuberculosis, jaundice, pernicious anemia and of many other conditions. Renal function is rarely impaired and œdema and hypertension do not occur.

NECROTISING NEPHROSIS

This is similar to the preceding variety in its pathology, but the degenerative processes are more severe and actual necrosis of the tubular epithelium is present so that renal function may be grossly impaired. It occurs only occasionally after infections and then generally in very severe cases. Necrotising nephrosis most commonly results from poisoning with various chemical agents particularly with the salts of the heavy metals, such as mercury, bismuth and gold. It is most frequently encountered as a result of poisoning with bichloride of mercury. It may also result from poisoning with phosphorus, neo-saltarsan, chloroform and lysol and may complicate yellow fever, cholera, diabetes, high intestinal obstruction and sometimes toxæmia of pregnancy. It causes oliguria and anuria which unless relieved lead to death from uræmia.

ACUTE NEPHROSIS

This is clinically a fairly distinct group though pathologically it may only be an exaggerated example of the larval variety. It occurs mostly in young children of either sex, in whom marked generalised œdema with gross albuminuria arises without obvious cause or may frequently follow an acute pneumococcal infection of any part of the body. The kidneys are large, smooth, soft and either pale or congested. Microscopically the chief lesion is a well marked cloudy swelling of the renal tubules. Although the onset is comparatively rapid the course may be slow and the condition may become chronic. It is believed that approximately a third of the cases recover after some months but in others relapses are common often caused by some intercurrent infection. Such episodes are often fatal. Pneumococcal peritonitis is a frequent complication and accounts for many deaths though it is not invariably fatal. Surgical intervention for pneumococcal peritonitis complicating any form of nephrosis is of uncertain value. *The proportion of recoveries is about the same with or without open operation and the writer is now inclined to avoid surgical interference removing purulent effusions when possible and necessary by aspiration.*

CHRONIC NEPHROSIS

There is probably no essential difference between simple chronic nephrosis and chronic hyoid nephrosis the latter term being used to describe those cases in which hyoid changes are

most marked. There is perhaps a tendency for these latter cases to run an even more chronic course.

Munk, in 1913, pointed out that chronic parenchymatous nephritis (large white kidney) really comprised two distinct diseases with a quite different origin, course, and termination. The vast majority began as an acute diffuse glomerulo nephritis, though this phase was often inconspicuous and terminated in azotæmia with hypertension. This group is now referred to as the nephrotic stage of chronic glomerulo nephritis. There was also a smaller group of cases indistinguishable from these clinically but in whom no history of an origin from acute glomerulo nephritis could be obtained, and who rarely, if ever, developed either azotæmia or hypertension. This form of Bright's disease is now known as chronic nephrosis. It is a comparatively rare disease and the majority diagnosed on such clinical grounds are later discovered to be examples of the nephrotic stage of chronic glomerulo nephritis. However numerous authenticated cases have now been described, and most authorities admit its claim as a distinct variety of Bright's disease. Pathologically the kidney is enlarged, soft, smooth, and pale, with a capsule which strips readily. The cut surface looks and feels greasy and contains numerous yellow areas of fatty degeneration. Microscopically the chief lesion is a marked degeneration with fatty change in the cells of the proximal convoluted tubules. There is a considerable deposition of doubly refractile lipoids in the cells. The lumen of the tubules is often filled with epithelial debris and casts. Regeneration of tubular cells is common. The glomeruli with ordinary stains appear normal, but with special staining methods thickening of the basement membranes of the capillaries of the tuft and of Bowman's capsule can be seen. These changes, though slight, are constantly present and are of great theoretical importance, as suggesting that chronic nephrosis can no longer be regarded as a degeneration confined to the tubules but that a glomerular element is also present, though whether this is of primary importance is not yet known. It is also believed by some that there is a late or terminal stage in rare instances of chronic nephrosis, in which the kidney becomes contracted and granular.

Ætiology.—Chronic nephrosis is essentially a disease of childhood and young adult life. Some cases definitely follow infections elsewhere in the body, such as syphilis, diphtheria, pneumonia, and tuberculosis, but the majority arise without known cause.

Pathogenesis.—The outstanding clinical feature of chronic nephrosis is the gross oedema and anasarca associated with

less than 0.1 per cent) It often has a milky or opalescent appearance, due to the presence of lecithins Doubly refractile lipoids are frequently present in the urine, but are not characteristic, and are often met with in other conditions, notably the nephrotic stage of chronic glomerulo-nephritis The plasma volume is not increased except just prior to the onset of diuresis and the consequent diminution of the oedema Despite the pallor, anæmia is not a striking feature and severe anæmia is rare When other causes for anæmia are present, such as bleeding hæmorrhoids or a uterine fibroid, anæmia develops with alarming rapidity and out of proportion to the severity of the primary cause Both water and chloride elimination are diminished, but the defect is chiefly or entirely extra renal Since renal function is normal, uræmia does not occur The basal metabolism is often extremely low A mild degree of retinal oedema is not uncommon, but retinitis is not seen

Sufferers from chronic nephrosis are unusually susceptible to intercurrent infections, and these constitute the chief danger to life Pneumococcal infections are the most common, and death from pneumococcal peritonitis is frequent, especially in children In older subjects, streptococcal infections are relatively more common than in children Erysipelas may occur, spread rapidly, and prove fatal

It is doubtful whether chronic lipid nephrosis differs from chronic simple nephrosis except in degree The comparatively few well authenticated cases described mainly indicate an even more chronic and severe form of the latter disease All the signs and symptoms, but especially the lipid changes in the blood, urine, and kidneys are more pronounced, of longer duration, and are less subject to spontaneous remissions or amenable to treatment

Diagnosis —The chief difficulty in diagnosis is to differentiate chronic nephrosis from the nephrotic stage of chronic glomerulo-nephritis In some cases this can be done where there is a definite history of an attack of acute nephritis or gross hæmaturia following a sore throat or scarlet fever, but in many the distinction cannot be made The subsequent appearance of hypertension, retinitis, or azotæmia may, of course, determine the true nature of the case From amyloid nephrosis the diagnosis may again prove difficult or impossible A history of long continued bone sepsis or tuberculosis may help, and enlargement of the kidneys, liver, and spleen suggest a diagnosis of amyloid disease In cases with only moderate generalised oedema the clinical appearance may simulate myxœdema

Prognosis—The disease, if not cut short by intercurrent infections, normally runs a very prolonged course, with periods of months or years of remissions and exacerbations. Some patients, especially children, recover completely, but on the whole the prognosis is not good.

An important variety of chronic nephrosis which merits special consideration is that due to syphilis. Syphilitic nephrosis occurs chiefly during the secondary stage of syphilis and is characterised mainly by gross albuminuria with relatively few or no casts and in Great Britain little or no oedema in the majority of cases, though sometimes this may be extensive. Many cases respond well to anti-luetic treatment, but exceptions occur in which non-specific treatment is more effective.

TREATMENT OF CHRONIC NEPHROSIS AND THE NEPHROTIC SYNDROME

Diet—The main indications are for a diet high in protein but low in salt and fluid content. In only a minority does a high protein diet alone clear up oedema, and then only in the milder cases and especially in children. Often, too, it does not materially increase the protein content of the plasma. Nevertheless it does no harm and may do good. Protein to the extent of 120 to 240 grm per diem may be given. There is experimental evidence that some proteins are more potent than others in causing regeneration of plasma protein, but this has not yet been observed in man, and in practice it is more convenient to rely on those foods which contain a large amount of protein such as eggs and meat. The only time when it is advisable to give a low protein diet in chronic nephrosis is when the oedema is extreme and is causing urgent symptoms. It may then be wise to rely on the vigorous use of diuretics alone because of their more rapid action. A high protein diet (when first used) retards the effect of most diuretics and should be omitted until the bulk of the oedema has been removed, when it should always be given. The course of chronic nephrosis is so prolonged that a strict salt free diet cannot be maintained throughout. It should only be used in conjunction with diuretics, and then that recommended for acute nephritis will be found suitable (*vide* p. 650). At other times the salt intake should be restricted to about half the normal, which may be achieved by forbidding added salt but permitting that ordinarily used in cooking. The fluid intake should be mildly restricted to the minimum which can be taken with comfort by each individual. There is great danger in too rigid a restriction of

fluid especially in children. The patient should never be allowed to become thirsty. Generally between two and three pints per twenty four hours will suffice for adults.

Medicinal Treatment—This consists in the use of diuretics. The value of diuretics in chronic nephrosis has been underestimated chiefly through insufficient experience in their use. The custom of trying one diuretic after another in a more or less perfunctory manner is to be deprecated. Great judgment and experience are required in their selection and use in individual cases. They are to the physician what the knife is to the surgeon. It is as well to remember that many diuretics cause a temporary increase of oliguria and œdema before diuresis sets in and that this is not necessarily an indication that they are doing harm and should be discontinued but rather that they should be employed for longer periods and used more vigorously.

Diuretics—*Water* is the most generally useful diuretic but is contraindicated in nephrosis in which the œdema is largely extra renal.

Salts—The monovalent kations alone are absorbed from the alimentary tract with sufficient readiness for general use. Of these potassium is the most powerful as a diuretic. Sodium should not be employed except to act as a brake on the action of potassium and possibly to counteract the alleged toxic effects of the latter when used in very large doses. Potassium is generally given either as the citrate or chloride and the former is more effective. Multivalent kations such as calcium are best given by intramuscular injection. Salts which produce acidosis such as ammonium chloride and calcium chloride may be employed. In practice their use is limited firstly because they cannot be given in effective doses for a sufficient length of time without causing severe gastro intestinal disturbance and secondly there is danger of increasing the existing acidosis of renal insufficiency when this is present i.e. in patients in the nephrotic stage of chronic glomerulo nephritis.

Alkaline salts chiefly in the form of potassium citrate with the addition of a suitable proportion of sodium bicarbonate to neutralise the toxic effects of large doses of potassium are probably among the most powerful diuretics known and the most certain in their action. They have the additional advantage that they may be given for very long periods even years in effective doses without upsetting the gastro intestinal tract so that they are of value not only for the reduction of œdema but for preventing its recurrence. They permit of a high protein diet being given at the same time and if renal

function be normal they are non-toxic. In the presence of impaired renal function the danger of alkalosis arises and they should not be given unless the case be in expert hands or in hospital where laboratory facilities for immediate blood analyses are at hand. Very large doses may be required up to 1000 gr or more per twenty-four hours. The amount given must be varied from time to time to suit changing conditions.

Urea is a safe and simple diuretic in doses of 15 grm by mouth thrice daily. It is uncertain in its action has to be continued for long periods confers no protection against recurrence and is effective in comparatively few cases.

Purine Derivatives—Caffein Theobromine (as theobrominae sodium salicylate or diuretin gr 10 to 20) and Theophylline or Theocin (gr 2 to 4) are chiefly of value in cases of renal disease in which the dropsy is mainly due to cardiac failure.

Mercurial Diuretics—Mersalyl and Neptal are most effective in dropsy due to cardiac failure but are sometimes of great value as adjuncts in the treatment of pure nephrosis. Impairment of renal function is an absolute contraindication to their use. Full details as to their administration are given elsewhere (*vide p. 57*).

Bismuth Salts—Bismuth sodium tartrate injected intramuscularly in doses of 0.03 grm is also a powerful diuretic but again is contraindicated with impaired renal function.

Thyroid Extract—This is used in chronic nephrosis in view of the low metabolic rate and because it is thought to increase the utilisation of protein. It is given in increasing doses up to 15 gr of the dry extract daily but in some cases even larger doses are required. It is rarely successful when used alone but is said to be occasionally a valuable adjuvant to other methods of treatment.

Parenteral Colloid Administration—In addition to a high protein diet various methods have been tried of increasing the colloid osmotic pressure of the blood plasma directly. Blood transfusions may be used for this purpose and occasionally cause a large though transitory diuresis. Quite often however they produce the opposite effect and induce a severe and even fatal anuria. Except in very special circumstances they should not be used. Plasma or serum may be used with greater safety as may repeated intravenous injections of gum acacia (a 3 per cent solution diluted with an equal volume of distilled water) to the extent of 1 grm of gum per kilo of body weight. The injection is repeated every third or fourth day. Both concentrated serum and blood plasma are on trial but at best cause only a transitory diuresis.

Diaphoresis and Purgation—These both result in the deviation of water from the renal tract, otherwise available for elimination through the kidneys, and cause extra renal azotæmia. They are both exhausting to the patient and should never be employed.

Decapsulation—The number of unequivocal examples of success resulting from this operation is very small, and it is now rightly falling into disuse. More hopeful is the possibility of inducing nerve block by the injection of alcohol in the region of the sympathetic ganglia and preganglionic fibres. This has been known to produce dilatation of the renal vessels with diuresis for periods of at least a month. This method, however, is still in the experimental stage.

Mechanical Drainage—Drainage of œdema fluid by paracentesis or Southey's tubes should not be undertaken except for the immediate relief of urgent symptoms due to pressure, or when other measures have failed. There are two dangers to be apprehended as a result of this procedure, first and most important, it leads to deviation of fluids from the renal tract, and causes oliguria with consequent extra renal azotæmia which is not uncommonly fatal, and secondly, there is a definite risk of local sepsis and erysipelas leading to fatal consequences. The strictest aseptic precautions must therefore always be observed. The site of puncture is of little consequence provided maximum drainage be secured. Fluid should be aspirated from the pleural cavities if the heart be displaced or embarrassed. If ascites is causing distress the fluid should be withdrawn. If there is possibility of a purulent effusion an exploratory aspiration may be required. In many cases mechanical drainage alone fails and is followed by a return of the œdema. Sometimes, however, diuretics of all kinds fail, and repeated drainage may be the only method available and sometimes, though rarely, proves permanently successful in eradicating the œdema.

Removal of Foci of Sepsis—There is no evidence that tonsillectomy, drainage of para nasal sinuses etc., are of value in chronic nephrosis. The rule should be to avoid interference in these cases unless the treatment of the local lesion itself is imperative.

AMYLOID NEPHROSIS

Amyloid nephrosis presents a remarkable instance of the difficulty of finding an adequate system of classification for the nephropathies for whereas the essential lesion in this disease is a primary degeneration of the vasculature of the

kidney—the glomerular vessels—the signs and symptoms (except in the rare cases of amyloid contracted kidney) are exclusively those of a nephrosis, namely, albuminuria and œdema without hypertension or azotæmia. Amyloid nephrosis is only found in association with long standing suppuration especially in chronic tuberculous lesions which become secondarily infected, pulmonary cavities and bone and joint disease, chronic empyema osteomyelitis bronchiectasis, and pyonephrosis. It may be met with in syphilitic bone disease with infected anuses. Amyloid change is generally present in other organs as well, notably the liver and spleen. Clinically the chief features are gross albuminuria leading to generalised œdema. In rare instances a secondary contraction of the kidney develops with impairment of renal function, loss of œdema, and even hypertension. The diagnosis is often difficult or impossible, on account of the clinical similarity to chronic nephrosis. The presence or history of long-continued sepsis or tuberculosis, enlargement of the kidneys, liver, or spleen may be of value. If Congo red be injected intravenously, 30 per cent of it disappears from the blood in normal persons in one hour, but in amyloid disease 40 to 100 per cent leaves the blood in the same period. Absorption of the dye is also more rapid in chronic nephrosis and in the nephrotic stage of glomerulo-nephritis than in normal persons, but except with amyloid disease not more than 60 per cent disappears in one hour. Amyloid disease is usually fatal. Instances of complete recovery, however, have been recorded. The treatment is essentially that of the underlying condition, and the administration of a high protein diet which may be supplemented with increasing doses of thyroid extract. Diuretics may be tried but are usually less successful than in chronic nephrosis.

PREGNANCY AND RENAL DISEASE

No description of the chronic nephropathies would be complete without a reference to the renal complications of pregnancy which are numerically so important. It is estimated that some 10 to 12 per cent of the renal complications of the toxæmias of pregnancy result in chronic "nephritis," and certainly disorders of pregnancy appear to be the most common cause of chronic Bright's disease in women of middle age. The type of "nephritis" which follows such disorders affords another example of difficulties of classification for in their earlier and most typical forms they resemble principally the nephroses with albuminuria and perhaps some œdema but no

hematuria, azotemia, or hypertension. The severer forms, on the other hand, though still in the early stages i.e., pre-eclampsia and eclampsia, are clinically more allied to acute nephritis without gross hematuria, and to the nephrotic stage of chronic glomerulo nephritis, in that hypertension, and in some cases a mild diminution of renal function are added to the picture. Pathologically, the most striking lesions are found in the tubules, but thickening of the basement membranes of the capillaries of the glomerular tufts and capsules are also found, as in chronic nephrosis. Unlike chronic nephrosis, however, and amyloid nephrosis, a secondary contracted stage often develops many years after the original attack. The clinical picture then becomes that of a granular kidney or nephrosclerosis. The *pregnancy kidney* combining as it does the most prominent features of the chief types of the acute and chronic nephropathies, is in a class by itself. Treatment is both preventive and "curative" 40 to 50 per cent of albuminurias of pregnancy recur in subsequent pregnancies and chronic "nephritis" generally follows repeated attacks. Further, the longer the duration of the albuminuria the more likely is chronic renal disease to supervene. It is therefore of great importance (a) to prevent albuminuria of pregnancy, and (b) if this is not possible, to shorten its duration. Preventive treatment is of two kinds, medical and surgical. Adequate ante natal supervision is by far the most valuable aspect of medical treatment but may with advantage be supplemented by other measures. Thus it has been shown that the prophylactic use of alkalis, as described for the prevention of post scarlatinal nephritis (*vide p 690*), also diminishes the incidence of recurrent albuminuria if given at the onset of pregnancy and continued systematically throughout. If albuminuria develops in spite of these measures then the patient must be confined strictly to bed and given a salt free diet in addition to the alkalis. The majority of cases clear up with this treatment, but if after three weeks there is not sufficient improvement induction of labour must be seriously considered. A strict salt free diet should not generally be continued for longer than three weeks during pregnancy. The medical treatment of the severer grades of albuminuria of pregnancy, pre eclampsia, and eclampsia is essentially that of pseudo uræmia—strict salt-free diet, limited fluid intake, and the production of the maximum diuresis best induced by adequate doses of potassium citrate by mouth (sodium salts should on no account be used). In severe cases with hypertension and convulsions, generous, and if necessary repeated venesections,

followed by lumbar puncture and the free use of narcotics such as morphia chloral, and the harbiturates, but preferably not chloroform, should be used. Purgation and measures to induce diaphoresis are contraindicated.

THE PRIMARY NEPHROSCLEROSES

Although it is convenient to include the primary nephroscleroses under the heading of Bright's disease, they are not strictly examples of nephritis, but primary degenerations of the general arterial system in which, however, the renal vasculature is heavily, and often mainly, involved. Arteriosclerosis and arteriolosclerosis are described elsewhere (*vide* p. 567). In all cases of arteriolosclerosis the renal vasculature is to some extent involved, but in only a comparatively few (approximately 7 to 15 per cent) are the renal lesions sufficiently pronounced to dominate the clinical picture and to cause death from renal failure. It is this small group which constitutes the clinical entity "primary nephrosclerosis." Arteriolosclerosis in general, however, is so universally prevalent after middle age that the primary nephroscleroses are numerically an important group and are in fact, the most common variety of Bright's disease.

The primary nephroscleroses may be divided into two main categories—the Arterioloscleroses and the Arterioscleroses.

RENAL ARTERIOLOSCLEROSIS

(Syn. Primary Granular Kidney, Red Granular Kidney, Small Red Kidney, Kidney of Essential Hypertension.)

Primary granular kidney is numerically the most important group formerly included under the term 'chronic interstitial nephritis.' It is essentially a disease of middle and late middle life, the maximum incidence being between 40 and 65 years, though it is not uncommon in the seventh decade. It is equally common in both sexes.

Ætiology.—It is important to realise that primary granular kidney is a result of long continued hypertension, which causes secondary changes in the renal arterioles. Such changes are found in practically all cases of essential hypertension (*vide* p. 569), though in only comparatively few are they sufficiently marked to justify the diagnosis of granular kidney pathologically, or "chronic interstitial nephritis" clinically. Little is known of the true causes of essential hypertension, though heredity, obesity, and the stress and strain of life under modern

conditions are believed to be important contributory factors. Lead, gout, and alcohol were also once considered to be potent causes of granular kidney, and indeed may have been so formerly, but in many countries the influence of these agents has long been on the decline, whilst the incidence of granular kidney has simultaneously increased.

Morbid Anatomy—The kidneys at autopsy range from those of quite normal size and appearance to the extremely small red granular kidney. In the typical arteriosclerotic kidney, the capsule is firmly adherent, the surface finely granular and often of a dull red colour, and there is an excess of fat in the pelvic region. On section the organ is tough and hard and the cortex is narrowed and not well differentiated from the medulla. Small cysts frequently occur in the cortex and beneath the capsule of the kidney. Histologically the essential lesion can only be made out in the earlier stages and is seen to consist of a thickening of the intima of the terminal arterioles and their parent vessels, which tend to undergo fatty degeneration, and may occlude the lumen. In the kidney these changes are evident in the afferent glomerular vessels and the interlobular vessels. When the former are involved, the corresponding glomeruli undergo hyaline degeneration, fatty changes, fibrosis and atrophy. Finally, the corresponding tubules become atrophied and replaced by fibrous tissue. Small areas of fibrotic renal tissue are then found separated by larger areas of normal kidney. Later, the number and size of these fibrotic areas increase at the expense of the normal renal tissue until finally the whole kidney becomes almost replaced by fibrous tissue and few normal elements can be found. In the majority even in this stage death occurs from either heart failure or cerebral hæmorrhage. The remainder die from uræmia. Death from uræmia may also occur when the renal arteriosclerosis has not advanced to this extent but in such cases the renal arteriosclerosis is accompanied by arteriolar necrosis and endarteritis. This condition is known clinically as *Malignant Hypertension* (*vide p. 574*), because in contrast to essential hypertension it tends to run a rapid and inevitably fatal course, often of only a few months. Malignant hypertension is also apt to occur in the comparatively young, the age incidence in general being some ten years lower than in the essential type. It is now believed that malignant hypertension is not a disease *suæ generis* but is the clinical syndrome which accompanies the specific necrotic arteriolar changes just mentioned and that it occurs only when the diastolic blood pressure has been considerably and persistently increased.

but of the media, is not accompanied by hypertension, unless, as often happens, essential hypertension also is present, and it is chiefly a disorder of old age. The kidneys are not seriously affected and never sufficiently to give rise to symptoms. Renal arteriosclerosis is not therefore a clinical entity.

Lead Nephritis in Children—Nye has described a form of chronic nephritis in children which is prevalent in Queensland. Clinically it is characterised by persistent hypertension with cardiac hypertrophy, albuminuric retinitis, chronic anaemia, and symptoms of uræmia. It appears that lead paint, used on the wooden verandah railings of houses, becomes blistered and powdery in the sun, and that the children get lead poisoning by licking the paint off the railings and their fingers. Statistical inquiry showed that nearly all the victims were habitual nail biters. Histologically the lesions principally affected the renal vasculature. The course is one of progressive destruction of renal tissue and death from uræmia.

Renal Dwarfism (Syn. Renal Infantilism, Renal Rickets)—Renal dwarfism is defined by Barber as 'a condition of stunted development, associated with bone deformities of the late rickets type, due to an insidious chronic interstitial nephritis of obscure ætiology.' The sexes are about equally affected, and it may occur occasionally in more than one member of a family. The onset is insidious, and it may not be observed until six or seven years of age that development is retarded. In other cases, evidence of renal insufficiency may be the first manifestation. Genu valgum is usually the most marked bony lesion, but the deformities may be widespread. Intelligence is unimpaired. The initial lesion appears to be a chronic progressive, and possibly congenital, nephritis. Histologically the renal lesions are of great variety and complexity. In some, typical arteriosclerotic lesions are present, and in such cases hypertension, cardiac hypertrophy, and even retinal changes may be found. In others there are various forms of glomerulitis without marked primary vascular lesions or hypertension, cardiovascular changes are, in fact, more often absent than not. Long standing impairment of renal function induces increased excretion and diminished absorption of calcium. In an attempt to maintain the concentration of calcium in the blood at a normal level this substance is withdrawn from the soft growing bones with the production of the characteristic bony deformities. The prognosis is inevitably hopeless. Death from uræmia is the rule, often precipitated by intercurrent or injudicious operative interference. Most cases

(above 120 mm Hg) for a long time. Malignant hypertension therefore is met with not only in the advanced stages of essential hypertension but whenever there is prolonged and marked elevation of the diastolic pressure. Thus it not uncommonly accompanies and complicates the hypertension and arterial changes generally found in chronic glomerulo nephritis. The main clinical features of the malignant hypertensive syndrome are those of increased intracranial tension—headache, nausea, vomiting, annurosis, papilloedema, convulsions, coma and other manifestations of hypertension encephalopathy.

Symptomatology—The symptomatology of renal arteriole sclerosis (primary granular kidney) is, in the early stages which may be of many years' duration, that of essential hypertension which is discussed elsewhere (vide p. 570). The only signs and symptoms which can be attributed directly to the renal involvement are (a) changes in the urine, such as mild albuminuria and the presence of an increasing number of casts, and (b) the usual signs and symptoms of impairment of renal function and of renal insufficiency which have been fully described above (see Uremia p. 681). Compensatory polyuria, generally evident as nocturia and one of the earliest and most constant signs is really evidence of impaired renal function. Albuminuria is usually slight and may be intermittent. Large quantities generally mean cardiac failure. In the malignant phase, however albuminuria may be marked. Hyaline, and occasionally granular casts are often present, and again in the malignant stage may be abundant. Red blood cells are not found in the benign phase but in malignant hypertension are almost constantly present on microscopic examination, and attacks of gross haematuria frequently occur. Clinically it is important to note that malignant hypertension may present itself in two forms: either the patient who is often relatively young is unaware of previous hypertension and attends for the sudden onset of violent headaches, "lithous attacks," or amaurosis, or perhaps retinal changes are found on routine examination or similar symptoms develop more or less gradually, in one long known to be the subject of hypertension. The course in the former group is generally more rapid. Malignant hypertension frequently accompanies basophil hyperplasia or adenoma of the pituitary body (Cushing's syndrome, vide p. 257).

RENAL ARTERIOSCLEROSIS

This differs from arteriole sclerosis in affecting the medium size vessels only. It is primarily a disease not of the intima

but of the media is not accompanied by hypertension unless as often happens essential hypertension also is present and it is chiefly a disorder of old age. The kidneys are not seriously affected and never sufficiently to give rise to symptoms. Renal arteriosclerosis is not therefore a clinical entity.

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die at or before puberty, but a few have been reported as surviving to the second or third decade. The treatment is that of chronic nephritis. Deformities may be controlled by mechanical means, but operations under general anaesthesia are to be avoided. Ultra violet radiation aggravates the bony lesions and is contraindicated.

Renal dwarfism is sometimes associated with congenital hydronephrosis, chronic pyelonephritis, congenital cystic disease of the kidneys, and multiple renal calculi.

HYDRONEPHROSIS AND PYONEPHROSIS

Hydronephrosis is an aseptic retention of urine in the kidney or renal pelvis due to obstruction to the flow of urine. It may be unilateral or bilateral, congenital or acquired.

Ætiology—Congenital hydronephrosis is rare and occurs usually in male infants as a result of congenital stenoses and septa in the ureter or urethra. It may accompany abnormal developments such as horse-shoe kidney, or double ureters, or extra renal anomalies such as spina bifida and imperforate anus. Acquired hydronephrosis may be due to (1) Supra vesical causes—calculi within the renal pelvis or ureters, torsions, thickenings and kinks at the uretero pelvic junction, inflammatory septa and bands from chronic pyelitis, traumatic strictures following calculi, growths in the ureter and bladder, and compression of the ureter by abdominal tumours, movable kidney, aberrant vessels, abdominal adhesions and bands, chronic pelvic cellulitis and malignant growths of the cervix uteri. (2) Infra vesical causes—stones or foreign bodies in the urethra, strictures of the urethra and prostatic enlargement, pelvic tumours, enlargement of uterus, fibroids, ovarian cysts and growths and uterine prolapse. Numerically the most important of these are impacted calculi, and due mobility of the kidney and aberrant vessels. In not a few cases, however, no obvious cause can be found.

Pathology—Whatever the cause, unrelieved obstruction, partial or intermittent, leads to dilatation of the ureter, pelvis and calyces and finally atrophy of the pyramids and cortex of the kidney. Ultimately the kidney is completely destroyed and replaced by a sac lined by fibrous tissue. A unilateral hydronephrosis does not cause renal insufficiency, owing to the hypertrophy of the unaffected kidney. A relatively small infra vesical lesion will cause impairment of renal function as both kidneys become involved. In the latter, however, symptoms will develop more slowly, as the bladder acts as a

reservoir which prevents serious back pressure for a considerable time. Distended vessels on the inner surface of the hydro-nephrotic sac may rupture and cause hæmaturia.

Symptoms—In the early stages there may be no symptoms. Unilateral hydronephrosis is more liable to give rise to symptoms than the bilateral variety. Pain usually occurs intermittently and simulates renal colic. There may be a continuous dull ache in the loin, vomiting, polyuria, and occasionally hæmaturia. In the later stages a tumour may be felt and the patient may be aware of its intermittent appearance.

Diagnosis—A renal tumour with a normal urine strongly suggests hydronephrosis. Early cases can only be diagnosed with certainty by pyelography, when the characteristic flattening or "clubbing" of the calyces will be evident. Cystoscopy will reveal diminution or absence of urine from the affected side. Retrograde pyelography, in which a solution of sodium iodide is injected up the ureteric catheter, was introduced in 1906 by Voelcker and Von Lichtenberg, and the resulting pyelogram may demonstrate the characteristic lesion in the calyces. More recently Von Lichtenberg and Bunz and Roeth have developed another method of extreme value—excretion urography—in which X-ray photographs of the urinary tract are obtained after the intravenous injection of non-toxic substances which are selectively excreted by the kidneys. Among the most successful of these substances are pyelectan (Glaxo), uropro (May & Baker), and uroselectan B (Schering), which are rapidly excreted by the kidneys in high concentration suitable for radiography. The only contraindications to the use of these drugs are severe kidney (azotæmia) and liver disease, and very acute inflammatory lesions of the urinary tract.

Prognosis—The prognosis varies with the cause and the completeness with which it can be removed. The chief danger, apart from gradual destruction of the kidneys, is that the sac may become infected and result in a pyonephrosis.

Treatment—The treatment is entirely surgical.

Pyonephrosis—Pyonephrosis is a distension of the renal pelvis with pus. It arises as a sequel of pyelitis, or from infection of a hydronephrosis. Renal calculi are the commonest cause. Tuberculous pyonephrosis is a not uncommon complication of tuberculous kidney (*vide p. 13*). The symptoms in the early stages of pyonephrosis are those of hydronephrosis, and the onset of infection is ushered in by pyrexia and rigors. The treatment consists of nephrectomy provided the function of the other kidney permits. The treatment of bilateral cases is purely palliative.

BACILLUS COLI INFECTIONS

Bacillus coli communis (B C C) may appear in the urine without causing constitutional symptoms and is then known as bacilluria. When coli bacilluria is accompanied by pyuria inflammation of some part of the urinary tract has occurred. If the inflammation is confined to the renal pelvis the condition is known as *pyelitis*, and if to the bladder, *cystitis*.

Acute B C C Pyelitis—*B. coli* are the infecting organisms in 75 per cent. of cases of acute pyelitis the remainder usually being due to streptococcal and staphylococcal infections. In the majority the path of infection is believed to be by the blood stream but in some it is apparently an ascending infection from the bladder either directly or through the peri ureteral lymphatics. Whatever the path of infection, its location in the renal pelvis is determined by certain factors, of which local trauma either from external injury, or internal injury from a calculus obstruction to the urinary flow, and lowered resistance of the patient to infection in general are the most important.

Pathology—The local lesion consists of an acute inflammation of the mucosa and submucosa of the renal pelvis, which in chronic cases leads to ulceration and scarring with consequent deformities.

Symptoms—The symptoms of acute pyelitis are those of an acute bacteriæmia together with those of inflammation of some part of the urinary tract accompanied by bacilluria or pyuria. There may be a short prodromal stage with malaise, headache, anorexia, constipation and perhaps frequency of micturition. In this stage the urine may contain only traces of albumen, a few leucocytes, and growth of B C C is scanty. It is important to note that in the first few days it may not be possible to establish the diagnosis from examinations of the urine. The onset of the acute stage is sudden with great frequency, half or quarter hourly, strangury, abdominal pain, tenderness and pseudo rigidity. The temperature rises to 103° or 104°, and there may be rigors. In some cases there is frank hæmaturia. Generally the urine is scanty, highly coloured with a very acid reaction, turbid or opalescent and has a characteristic 'fishy' odour. Constipation is present and there may be frequent vomiting. Later the pain becomes localised to one loin and is often of a dull, aching character. Headache may be a prominent symptom, and toxic delirium and even coma may occur. The patient is flushed and the tongue is dry and coated. Careful palpation may show that the affected kidney

is enlarged and tender. There is a marked leucocytosis during the stage in which there is not much pus in the urine. When pyuria becomes abundant the leucocytosis decreases. Blood cultures are frequently positive in the earlier stages. In some the symptoms are chiefly those of cystitis although the bladder may have been secondarily infected from the renal pelvis. With cystitis there is usually much mucus in the urine.

Course—The course is very variable. The acute stage may subside in a few days or weeks. The temperature falls by lysis and the local symptoms disappear. In most cases bacilluria and pyuria persist in microscopical amounts for months after the actual symptoms have subsided. Recurrences are not uncommon after complete recovery and are usually precipitated by intercurrent infections, such as catarrhal colds or influenza or by injudicious purgation. In severe cases the infection may spread and involve the renal parenchyma, a condition known as pyelonephritis or surgical kidney. Pyelitis in children occurs most commonly under two years of age, and almost exclusively in females. The constitutional symptoms are frequently very marked and out of proportion to the urinary signs. The disorder may begin as a gastro intestinal disturbance, or may closely simulate appendicitis or meningitis. It is one of the rare causes of rigors in children under two years of age, a fact which may be of some diagnostic importance.

Differential Diagnosis—In the early stages with minimal urinary signs the malaise and pyrexia may simulate influenza, and the persistent headache, typhoid. When the abdominal signs are marked, differentiation from an acute abdomen, i.e., appendicitis, peritonitis, cholecystitis or salpingitis may be difficult. A careful and repeated examination of the urine will generally lead to a correct diagnosis though this may not be possible for a few days.

CHRONIC PYELITIS

Chronic B C C Pyelitis is usually a residual infection of the renal pelvis, following an acute attack, and may persist for months or years, or may be permanent. It may be quiescent or responsible for repeated acute attacks of pyelitis or cystitis. Sometimes the symptoms of pelvic infection are absent, though this is the cause of a persistent cystitis. The symptoms may be general or local. Of the general symptoms undue fatigue, headache, pain in the back, digestive disturbances, and symptoms of neurasthemia are the most common. The chief local symptoms are frequency of micturition, or urgency, and

pain in the loin or region of the bladder. It is important to remember that bacilluria may persist indefinitely without symptoms of any kind and may be quite innocuous. Constipation is a predisposing cause of acute exacerbations of pyelitis in those with chronic bacilluria, but more frequently they are caused by the injudicious use of purges. Chronic pyelitis may give rise to pyonephrosis.

Treatment—The first essential is to ensure that the pyelitis is a primary disorder and not a complication of some underlying condition, such as a calculus. Strict confinement to bed is imperative in the early stages. The diet can be left to the wishes of the patient. Large quantities of fluids (not less than 6 pints per twenty four hours), such as water, barley water, Contrexeville or milk, should be given. Purges should never be employed, as loose stools are contraindicated. The bowels may be kept open by lubricants such as paraffin, or simple enemata. The chief object of treatment is to maintain a large output of alkaline urine. Pus and organisms are literally washed out with the diuresis, and the growth of the latter is inhibited by the alkalinity of the urine. Alkalis must therefore be given by mouth, in doses large enough to render the early morning specimens of urine (the most acid of the twenty four hours) persistently and definitely alkaline ($\text{pH}=\text{above } 7.6$) until all signs of inflammation have cleared, i.e., usually for at least several weeks. As a rule, the pyrexia, pain, and tenderness subside within forty-eight hours of the urine becoming definitely alkaline, but return at once if the degree of alkalinity be allowed to diminish. The beneficial results of alkali therapy, when adequate doses are given, are so consistent and striking that other treatment is rarely called for, and indeed failure to respond generally means either that the original diagnosis was wrong, or that the condition is associated with mechanical obstruction in the urinary passages. In such cases further investigation by means of cystoscopy and ureteric catheterisation should not be delayed. Alkalis should be given as a mixture of equal parts of potassium citrate and sodium bicarbonate, gr. 30 to 60 of each, as many times a day as is found to be necessary to obtain and to maintain the required degree of alkalinity of the urine. The latter can be readily estimated daily (if necessary by the patient) in a very few moments, by noting the colour of the urine after the addition of a few drops of a 0.1 per cent solution of bromthymol blue, and comparing this with a standard indicator.* As a rule some 400 to 600 gr. of alkali

* The B.D.H. Caillator, supplied by the British Drug Houses Ltd., is a convenient form of apparatus for the purpose.

per twenty four hours will suffice, but even larger doses may be required, especially at the outset. As renal function is unaffected, no danger from alkalosis need be apprehended. Tincture of hyoscyamus (M30 to 60) may be added to the mixture as an antispasmodic if required. Alkali treatment must not be relaxed, until by trial it is shown that a reduction of dosage is not followed by a return of pus or bacilli in the urine or of constitutional symptoms. In some cases it is necessary to continue treatment for months or years to prevent relapses. Alkalis will not, of course, be successful if mechanical obstruction to the flow of urine be present, as in the later stages of pregnancy. In such circumstances, and when it is not possible or desirable to deal immediately with the obstruction other methods are indicated. It has been found that growth of BCC in the urinary tract can be readily and often completely inhibited when the urine is rendered sufficiently acid especially in the presence of certain of the ketone bodies. For this reason the ketogenic diet was introduced for the treatment of BCC pyelitis. As, however, the effective degree of acidity is very high, it was necessary to supplement the diet which was itself extremely unpleasant, by a rigid curtailment of the fluid intake in order to induce a sufficient concentration of "acid" in the urine. These conditions could often only be maintained sufficiently long to produce a temporary cure so that the relapse rate was high. Pleasanter and much more effective is mandelic acid (Rosenheim) a substance related to the active principle (B hydroxybutyric acid) of the ketogenic diet. Mandelic acid is given by mouth in doses of 3 grm four times daily with ammonium chloride (15 gr) to provide the optimum urinary acidity (pH 5.3). They are sometimes combined and given as ammonium mandelate (3 grm three or four times daily). The fluid intake is restricted to less than 2 pints per twenty four hours. Very encouraging results have been obtained but, chiefly because the treatment cannot be continued for sufficiently long periods without causing severe gastro intestinal disturbances or damaging the kidneys, the relapse rate is again high. More recently still sulphadiazide and sulphapyridine (M & B 693), well known for their effects in streptococcal infections, have been found to give the most remarkable results in BCC infections of the renal pelvis. Details regarding administration of the sulphonamide group of drugs are given on p. 69. In urinary infections the dosage in adults should usually be a total of 3 to 5 grm per diem. No dietary or fluid restrictions need be imposed as it is effective within a wide range of urinary reactions (pH 5.2 to 6.8). There is

evidence that sulphonamides are even more effective when given in conjunction with alkalis. They are particularly valuable in children and during pregnancy. In chronic pyelitis after a thorough search has been made for mechanical causes of chronicity, such as impacted calculi anatomical deformities due to scarring of the calyces and pelvis, etc., sulphonamides should always be tried first and if they fail, mandelic acid. In long-established chronic *B. coli* pyelitis alkalis are chiefly of value when given continuously for months or even years for the prevention of acute exacerbations. Various so called urinary antiseptics, hexamine, hexyl resorcinol, and numerous other substances are frequently employed but the results are usually disappointing. Autogenous vaccines have long been in vogue but their value has certainly not yet been established. It must be admitted that the treatment of chronic BCC pyelitis is often unsuccessful.

PERINEPHRIC ABSCESS

Perinephric abscess is a condition due to the formation of an abscess in the perinephric tissues, either as a result of a hæmatogenous infection from a distant focus or more rarely by direct infection from the kidney or neighbouring structures. The infecting organism is nearly always the *Staphylococcus pyogenes aureus*.

Ætiology—Perinephric abscess may result from direct injury to the loin or from staphylococcal skin infections—carbuncle, furuncle or sycosis. The interval between the primary infection and the perinephric suppuration is usually from two to four weeks but may be as many months. It is occasionally due to streptococcal or pneumococcal infections and may follow tonsillitis, acute infectious diseases and influenza.

Pathology—The initial lesion is believed to be in the cortex of the kidney in the form of minute abscesses which penetrate the renal capsule and so reach the perinephric tissues. Pus accumulates behind the kidney and may point in the loin or it may travel down the psoas muscle to the groin or pelvis. It may rupture through the diaphragm enter the peritoneal cavity or the intestines or by lymphatic spread infect the pleural cavities and cause empyema.

Symptoms—The onset is usually insidious with vague symptoms of fatigue, malaise and pyrexia. Localising signs in the form of lumbago, pains in the loins or back, hip or thigh may not appear for two, three, or many weeks. A lump may be

the first obvious sign Tenderness in, and bulging of, the posterior renal angle are important signs. As the condition progresses, signs of toxæmia develop, pallor, sweatings, high "septic" temperatures, with or without rigors, occur, and the leucocyte count increases to 20 40,000 per cmm. There may be diminution of the breath sounds, and dullness on percussion over the base of the lung on the affected side. The diagnosis is confirmed by an exploratory puncture into the tumour. The urine is usually normal, but may contain a trace of albumen and a few leucocytes. Some cases of what appears to be perinephric suppuration undergo spontaneous resolution.

Diagnosis—In the early stages, lumbago, hip joint disease, rheumatism, and sciatica may all be simulated. In the pyrexial stage the diagnosis from influenza, typhoid, septicæmia, tuberculosis, and infective endocarditis may be difficult.

Treatment—The treatment consists in evacuating the pus by incision, but this should not be done until the suppuration is "ripe." If the temperature and suppuration continue after operation a renal carbuncle should be suspected. The prognosis is good in the vast majority of cases adequately treated.

Renal Carbuncle—This is a circumscribed abscess of the cortex of the kidney, consisting of a fusion of a number of smaller abscesses separated by a zone of granulation tissue from the rest of the kidney. It is usually unilateral and is due to a hæmatogenous infection by the *Staphylococcus pyogenes aureus*. Etiologically it is similar to perinephric abscess and usually follows furunculosis. The clinical signs are those of perinephric abscess and the diagnosis cannot usually be made before operation.

NEW GROWTHS

New growths of the kidney may be classified as —

- (a) Innocent tumours lipomata, fibromata, adenomata, angiomata.
- (b) Malignant tumours hypernephromata, carcinomata, sarcomata.

In addition there are new growths of the renal pelvis—innocent tumours—papillomata, and malignant tumours—carcinomata. Innocent tumours of the kidney are relatively rare, the adenomata being the most common. Most malignant tumours of the kidney are primary and the commonest is the hypernephroma originally described in 1893 by Grawitz and still

known by his name. It was thought by him to be a suprarenal rest, but is now considered to be either a malignant adenoma of the kidney or possibly a carcinoma of the renal tubules. It may occur at any age, and begins as a solid tumour of the upper pole of the kidney which later undergoes cystic degeneration with areas of necrosis and hæmorrhages. Microscopically, it resembles portions of the adrenal cortex. Metastases occur *via* the blood stream and involve the lungs, long bones, vertebræ, bones of the skull, or indeed almost any organ of the body. The secondary deposits may first draw attention to the condition. In the lungs a large circular opacity resembling a cannon ball may be seen on X ray examination. Sarcomata usually occur in children under five years of age and are therefore thought to be congenital in origin.

Signs and Symptoms — *In children* the first sign is usually a progressive enlargement of the abdomen, pallor, loss of weight, or pressure causing obstinate constipation, hæmaturia is comparatively rare. The most frequent form of new growth is a congenital sarcoma. The prognosis is extremely bad, though nephrectomy should be performed without delay in the absence of obvious secondary deposits. *In adults* the cardinal symptoms of malignant growths are hæmaturia, pain, and loss of weight. Hæmaturia is generally the earliest sign, and is present in over 75 per cent. of cases at some stage. Pain may be intense or merely a dull ache in the back or loin. Renal colic may be simulated by the passage of clots of blood down the ureters. The sudden appearance of a varicocele on the left side may be an initial symptom, as the left spermatic vein enters the left renal vein. The treatment of all forms of renal new growths is purely surgical. In connection with this subject it may be pertinent to mention two important rules of nephrology. (a) the most common cause of hæmaturia in children is some form of glomerulo nephritis, in adults over middle age malignant growths, and (b) hæmaturia in an adult should arouse suspicion of a malignant growth until this diagnosis has been disproved.

RENAL CALCULUS

Renal calculi consist of various crystalline or amorphous urinary constituents bound into a mass by a cementing substance. Little is known about the factors which contribute to the formation of stones. Among those believed to be of importance are the presence of an organic nucleus, stagnation

of the urine, and alterations in its colloid content. In size calculi vary from minute concretions to large single or multiple stones. In rather more than 10 per cent of cases they are found in both kidneys. Most calculi are of mixed composition, but pure stones may occur. Uric acid, calcium oxalate, calcium phosphate, and ammonio magnesium phosphate are the commonest varieties. Calcium carbonate, cystin, and xanthin stones are also met with. Although oxaluria may accompany calcium oxalate calculi it often occurs independently, following the ingestion of such vegetables as rhubarb, spinach, straw berries and tomatoes, or it may occur in patients with achlorhydria and gastric fermentation. Renal calculi occur at all ages but are most common in young male adults.

Symptoms.—Pain, usually lumbar, is by far the most frequent initial symptom. It may be sharp, or a dull ache intermittent or continuous, and in not a few cases may be referred to the region of the unaffected kidney. The attacks of pain may be accompanied by nausea and vomiting. On microscopical examination of the urine, blood and pus are frequently found. In some cases there are definite attacks of gross hæmaturia. When calculi are passing down the ureters, attacks of the most excruciating pain may occur, associated with vomiting, these attacks are typical and are referred to as *renal colic*. The pain usually starts in the loin or kidney region, and shoots down to the groin or testicle in the most agonising spasms. The patient is doubled up with pain, which may continue, with short intermissions, for several hours, unless morphia be given. The pain then diminishes and passes off, generally to recur some weeks or months later. Cessation of the pain does not necessarily mean that the stone has passed into the bladder, but more often that fatigue of the muscular wall of the ureters has set in. Hæmaturia commonly occurs after an attack of renal colic. Bilateral renal calculi may cause destruction of the renal tissue and so give rise to uræmia, other complications are pyelitis, pyelonephritis, hydro and pyo nephrosis.

Diagnosis—The typical nature and distribution of the pain, together with blood and pus in the urine, renders the diagnosis in many cases easy. In others the symptoms are less typical and may give rise to confusion with numerous disorders, the most common of which are—appendicitis, intestinal obstruction, sacro iliac disease, lumbago, gall stones, tabetic crises, or other renal disorders. Radiology, cystoscopy, and urography are invaluable aids to diagnosis.

Treatment—It is important to remember that most stones are passed spontaneously. The pain of renal colic may be

relieved by hot baths or the local application of hot poultices or hot water bottles to the loins. Copious drinks of hot lemonade, barley water, or weak tea are also of value. If these measures do not suffice, morphia—gr $\frac{1}{4}$ with or without atropine gr $\frac{1}{10}$ —should always be given and repeated if necessary. Inhalations of chloroform may be used until the morphia takes effect. Between attacks, the patient should lead a quiet life, avoiding sudden exertion of any kind, and drinking freely of mineral waters, to which either the citrate or bicarbonate of potash may be added. The radical treatment of stones which are not passed spontaneously, and are either causing persistent distress or infection of and damage to the kidney, is surgical.

POLYCYSTIC KIDNEYS

This is a comparatively common congenital abnormality occurring in about 1 in 600 autopsies. It is usually bilateral though generally one kidney is more affected than the other. It is often familial. Death usually occurs either in early childhood or in middle life. The liver and pancreas are also sometimes the seat of a similar cystic degeneration. The cysts vary in size and number, but eventually destroy the normal kidney tissue and lead to death from uræmia. The disease generally remains latent, though infrequent attacks of hæmaturia may lead to the discovery of enlarged kidneys. Signs and symptoms of renal insufficiency appear very slowly, and in no other condition is a high blood urea known to persist so long sometimes for several years, without other signs of renal failure. The diagnosis rests on the history of attacks of hæmaturia and the presence of enlarged kidneys, and especially upon the rather characteristic pyelographic appearances. The prognosis is ultimately extremely bad, and there is no treatment other than efforts to maintain a state of compensation for impaired renal function for as long a period as possible, and to observe extra care in avoiding exposure and chills.

A. A. USMAN

AFFECTIONS OF THE JOINTS AND BONES

ARTHRITIS

THE problem of evolving a satisfactory classification of arthritis is one which is not likely to be solved until we acquire a more complete knowledge of the aetiology of the condition. At the present time it is perhaps best to adopt the provisional classification of so called rheumatic diseases, suggested by the British Committee on Chronic Rheumatic Diseases. This is given below.

- Group 1 Rheumatic Fever Acute or Subacute
- Group 2 Acute Gout
- Group 3 Chronic Arthritis
 - A Rheumatoid type (atrophic, proliferative)
 - (i) Known aetiology (gonococcal, tuberculous, syphilitic, dysenteric, etc.)
 - (ii) Unknown aetiology (rheumatoid arthritis, Still's disease)
 - B Osteoarthritic type (hypertrophic or degenerative, chondritic)
- Group 4 Non articular Rheumatic Affections

Rheumatic Fever and Gout have been described elsewhere. Under the heading of arthritis of rheumatoid type of known aetiology are included many cases in which the primary origin of the arthritis is obvious. Thus not uncommonly in association with an acute local infection, particularly tonsillitis, there may occur an arthritis, involving one or more joints which rapidly become hot, swollen, and extremely tender. The joint cavity contains a turbid fluid, which does not, however, often progress to suppuration. The patient is usually severely ill and pyrexial. With immobilisation and rest of the affected joints the symptoms gradually subside, but there may be residual stiffness and limitation of movement for long periods. Such types of arthritis,

whether secondary to streptococcal, gonococcal, or other types of infection may reasonably be termed infective arthritis. Sulphonamides are of value in this type of arthritis.

When, however, all cases of arthritis of known origin are excluded, there remains a very large group where arthritis is the most prominent, though not necessarily the only manifestation of disease. Two very frequently encountered types of arthritis fall under this heading, and are known as rheumatoid and osteo arthritis, and, in addition, allied probably to rheumatoid arthritis, there are two relatively uncommon varieties, Still's disease and ankylosing spondylitis. Although in rheumatoid arthritis osteo arthritic changes may eventually supervene, the two conditions are completely different as regards their age and sex incidence, ætiology, and clinical manifestations, and they accordingly are described separately.

OSTEO ARTHRITIS

Some degree of osteo arthritis, particularly in the larger joints, is present in practically 100 per cent of persons over the age of fifty. Fortunately it often causes little or no disability.

Morbid Anatomy—Osteo arthritis may affect any joint, but it is most commonly encountered in the spine, the knees, hips, elbows, and acromio clavicular joints. The shoulders are less frequently involved. The condition may sometimes involve only a single joint, but more often several are affected though with varying degrees of severity. The primary changes are erosion and destruction of the cartilage, particularly at pressure points, and a thickening of the sub chondral bone due either to compression or new formation. In advanced osteo arthritis there is complete destruction of the articular surfaces, and where the bones come in contact they show a dense, hard surface described as eburnation. In addition, around the edges of the joint there are bony projections termed osteophytes. The synovial membrane is only involved secondarily.

Ætiology—Osteo arthritis is not a systemic disease with secondary joint manifestations but a primary disease of the joints themselves. Trauma is a frequent cause, and injuries even in relatively early life may many years later produce severe osteo arthritis. The incidence of the disease increases with age and the changes are almost certainly due to "wear and tear" of the articular surfaces. Focal infection probably plays no part in the production of the disease. Abnormal strain on joints produced by faulty posture ultimately results

in osteo arthritic changes. Considerable overweight also predisposes to osteo arthritis, particularly of the knee joints.

Symptoms—These will depend on the joints involved. Disability is usually greatest when the hip joint is affected.

On physical examination movement is often limited owing to the disorganisation of the joint, the presence of osteophytes, and the thickening of the capsule. Marked crepitus can be felt, due to erosion of the articular cartilage. Often osteophytes can be felt as small, hard projections around the edges of the joint. Pain is a very variable feature, sometimes when there is marked crepitus, joint movement is but little impaired and is practically free from pain. Patients with osteo arthritis often find that their pain is much aggravated in cold and wet weather, and is relieved by warmth. The blood sedimentation rate is within normal limits and there is no anaemia. The general health is unimpaired.

Treatment—From the nature of the disease cure is obviously impossible, but in severe cases considerable relief may be obtained by the use of surgical appliances such as caliper splints which help to relieve pressure on joints such as the knee or hip. Deep X ray treatment is sometimes helpful or in very severe disease of the hip joint, excision of the joint and ankylosis may relieve the pain. When the knees are chiefly involved, if the patient can lose a considerable amount of weight there is less strain on the joints. Sometimes manipulation under an anaesthetic is helpful. Aspirin is, perhaps, the most useful drug for the relief of pain and its continued use even in large doses rarely produces unpleasant symptoms. Diathermy and physiotherapy are often of great assistance.

Chronic Arthritis—At or about the period of the menopause it is not uncommon for arthritis to develop, affecting principally the knees. These become stiff and painful, and on examination are found to be enlarged, due to proliferation of the synovial membrane and thickening of the periarticular tissues. The patients are usually much overweight and show evidence of hypothyroidism. If the weight can be reduced by vigorous dieting the condition improves. Thyroid extract also appears to be helpful, but this may be due merely to its influence in producing a loss of weight. Sometimes the arthritis disappears when the menopause is past, but it may ultimately progress to osteo arthritis. Oestrogenic therapy (*vide p 284*) is also said to give good results. The joints should be supported by some form of elastic bandage. Massage, diathermy and endocrine therapy may also be tried.

At about the same period nodular swellings at the bases of the terminal phalanges are often found. These are known as *Heberden's nodes*. Initially the swelling is periarticular but eventually osteo arthritis may develop. The condition is seen occasionally in association with generalised osteo arthritis or rarely in patients with rheumatoid arthritis. More frequently it occurs in the absence of any form of arthritis elsewhere.

RHEUMATOID ARTHRITIS

This type of arthritis is sometimes also known as atrophic or infective arthritis. The disease affects mainly females the proportion being about seven females to one male and it is most common between twenty and forty. This is in striking contrast with osteo arthritis in which males are more often affected and the incidence increases with advancing years.

Morbid Anatomy—In rheumatoid arthritis any joint may be affected but those most constantly involved are the small joints of the hands and feet more particularly the proximal interphalangeal joints.

The disease begins in the synovial membrane and periarticular tissues which become thickened and proliferated and on microscopical examination show infiltration with lymphocytes and plasma cells. Later the proliferated synovial membrane becomes adherent to the articular cartilage which may be destroyed. The underlying bone becomes atrophied, and in the later stages there may be subluxation and sometimes fibrous ankylosis which however very rarely becomes a bony union. Even early in the disease there is striking wasting of the muscles surrounding an affected joint. In the fingers this produces the characteristic spindle shaped deformity.

Ætiology—In spite of an enormous amount of research the problem of the ætiology of rheumatoid arthritis remains unsolved. It certainly is not due to trauma though sometimes osteo arthritic changes may occur in a patient with rheumatoid arthritis. By many the disease is considered to be due to focal infection the site of the primary infection being thought to be variously in infected teeth tonsils sinuses gall bladder appendix urinary or genital tract. By some it is maintained that rheumatoid arthritis is due to intestinal toxæmia.

There are many features in rheumatoid arthritis which suggest that the disease is infective in origin. Among these are pyrexia tachycardia moderate leucocytosis increased sedimentation rate and evidence of general ill health such as anemia. Moreover histological examination of synovial

membrane and periarticular tissues show changes resembling those seen in inflammatory conditions. Further, positive agglutination and precipitin reactions to hæmolytic streptococci are often found in the serum of patients with rheumatoid arthritis.

If the disease is due to a local focus of infection there are three possible explanations for the development of arthritis: (1) that micro organisms actually migrate from the focus to the joints, in other words, that the arthritis is metastatic in origin, (2) that toxins formed in the focus of infection are absorbed and produce secondary changes in the joints, (3) that the presence of an infective focus produces a "sensitisation" of the tissues, and that rheumatoid arthritis is comparable with allergic manifestations, such as the joint conditions sometimes seen in serum reactions. None of these explanations can be regarded as wholly satisfactory. It is certain that the arthritis is not metastatic and bacteria are very rarely found in either the blood or the joints of rheumatoid arthritis. In favour of an allergic origin is the fact that a considerable proportion of patients with the disease show positive skin reactions to toxic products derived from hæmolytic streptococci.

If proof of the infective origin of rheumatoid arthritis is deficient, there is even less evidence in favour of other hypotheses. Endocrine dysfunction, deficiencies in diet, disturbances of the sympathetic nervous system have all been suggested as causal factors, but there is little or nothing to support any of these views, except that a type of arthritis does occasionally occur at or around the menopause, which is sometimes described as climacteric arthritis (*vide p. 731*).

In general it may be said that whatever be the mechanism underlying the development of rheumatoid arthritis, general ill health, malnutrition, and unhygienic surroundings play an important part as predisposing factors.

Symptoms of Rheumatoid Arthritis—These vary considerably according to the stage of the disease and its severity. The onset may be somewhat sudden, often with pyrexia, but in such cases a careful inquiry into the history will usually elicit the fact that vague joint symptoms such as pain and stiffness, had been present for some time before more acute symptoms developed. Much more frequently the onset is insidious, and it is only after several months that the patient is compelled to seek medical advice. As with so many other chronic diseases spontaneous remissions, partial or complete, are not uncommon.

The symptoms and signs may be dealt with most conveniently under two headings, the condition of the joints and the general symptoms.

Joints—In rheumatoid arthritis any joint may be affected but those most constantly involved are the small joints of the hands and feet more particularly the proximal interphalangeal joints. In addition to these any or all of the larger joints may show pathological changes.

In the earlier stages of the disease the most prominent symptoms are pain and stiffness and the latter is most marked when the patient awakes in the morning. On moving the joints the stiffness to a great extent passes off only, however, to recur after a period of rest. The earliest change is a thickening of the periticular tissues associated with variable amounts of fluid in the joint cavity. In the case of the interphalangeal joints there is a characteristic spindle shaped enlargement which is usually most obvious in the proximal joints. The skin over the affected joints is often pale waxy translucent and shiny. The temperature of the joints is usually subnormal and there is profuse local sweating of the palms and soles. When larger joints such as the knees are affected the joint becomes somewhat swollen and looks even larger than it really is owing to rapid wasting of the muscles in the neighbourhood. During the more acute stages of the disease the joints are tender on pressure and although movement is possible it is painful. When definite periticular thickening has occurred the deformity of the joint persists for long periods even though pain and tenderness may have disappeared.

In the more chronic cases of rheumatoid arthritis there is great deformity of the joints although bony ankylosis does not occur movement may be quite impossible owing to contracture and thickening of the ligaments. In the hands wrist-drop is common and ulnar deflection of the fingers is characteristic similarly foot drop may occur. The knees show a great tendency to become acutely flexed.

The synovial membrane is thickened but the only change in the bones is a rarefaction in the neighbourhood of the affected joints which renders them unusually translucent to X rays. In severe and very chronic cases however there may be erosion of the joint surfaces associated with subluxation and disorganisation of the joints and fibrous or rarely bony ankylosis.

General Symptoms—Although the most prominent symptoms are referred to the joints rheumatoid arthritis must be regarded in a broader aspect as a general disease.

In nearly all cases there is some pyrexia, which, especially during the more acute stages, may reach 102°F or higher. The pulse rate is often persistently raised, even though the patient is in bed but apart from this there is no evidence of cardiac involvement. The blood pressure in chronic cases is usually low. There is often a moderate secondary anaemia, usually with a definite polymorphonuclear leucocytosis. A markedly raised blood sedimentation rate is always found. The appetite is poor and the tongue furred. Headache and depression are common. Amelioration of the joint symptoms is usually preceded by an improvement in the general health.

Treatment—Attention to the general health is of prime importance. The patient should be nursed in an airy and well lighted room, or even better, on an open veranda. In the absence of sunshine ultraviolet light is often beneficial. A light diet with an abundance of fresh fruit and green vegetables is advisable, and meat should be either avoided altogether or strictly limited in amount. The patient must be encouraged to take plenty of fluids, such as orange juice or lemonade. In addition, wheat germ should be given, as it contains much vitamin B, and cod liver oil is sometimes beneficial. Blood transfusion is often recommended, especially in patients with considerable anaemia.

Focal Infection—Whatever views may be taken of the role of focal sepsis in the production of rheumatoid arthritis, there is general agreement that any obvious focal infection should be eradicated. Though such a procedure may have little immediate influence on the condition of the joints it is certainly beneficial as regards the patient's general health. While wholesale extraction of teeth is unnecessary and undesirable, any that show definite evidence of infection, whether on radiological or clinical grounds, should be extracted. Similarly, genuinely infected tonsils should be enucleated. Not more than one or, at most two teeth should be extracted at one time, as sometimes the operation may produce an exacerbation of the disease. In any case before extraction is performed the teeth should be scaled and the mouth rendered as clean as possible.

On the whole, treatment with vaccines, whether autogenous or stock, is disappointing. When an improvement does occur following a vaccine, it is possible that it may have been due to a 'protein shock' effect rather than to any specific action. As in so many chronic diseases any new treatment may for a time produce improvement, which is largely psychological.

Sulphonamides seem to be ineffective and are likely to add to the patient's discomfort

Protein shock Therapy—It has long been known that an acute pyrexial illness, occurring in a patient with rheumatoid arthritis, sometimes produced a temporary improvement in the condition of the joints. This suggested the production of fever by such methods as an intravenous vaccine or the injection of a protein, such as sterile milk. By these means it is possible to produce a transient pyrexia. After this has subsided there is sometimes a striking improvement. The hands and feet, previously cold and clammy, become warm and dry, pain and stiffness is also diminished. Unfortunately these effects are usually transitory. One method of protein shock therapy is to inject intravenously a vaccine of typhoid bacilli starting with a dose of about 30 million organisms. The injection is repeated about every fifth day for about a month, increasing the dose up to even 200 millions. The aim of the treatment is to produce a sharp pyrexial reaction lasting up to twenty four hours, and the dose of vaccine must be graduated with this end in view. Protein shock therapy is most likely to be helpful in the earlier stages of rheumatoid arthritis.

Artificial Pyrexia (Pyrotherapy)—The body temperature may be kept between 105° and 107° F by placing the patient in the Kettering hypertherm. This consists of an air conditioned cabinet in which the temperature and the humidity of the air can be controlled. Favourable results have been reported in many types of acute and chronic arthritis, especially gonococcal, by exposure in the hypertherm for periods of between five and seven hours. The treatment has to be repeated on several occasions.

Gold Therapy—During recent years the treatment of rheumatoid arthritis by gold has been tried, especially by Forestier. The compound usually employed is Solganol B, an organic preparation containing 37 per cent of gold. Intramuscular injections are given at intervals of four to five days for about six weeks. The initial dose is 0.01 grm, increasing up to 0.4 grm. The actual dose and the extent to which it is increased depend on the reaction produced. The aim should be to give such an amount of the drug as will produce an exacerbation of symptoms lasting twenty four hours. The total amount of the drug in a course should not exceed 2 grm. Further courses will be required after an interval of several months. The blood sedimentation rate is a guide to treatment. Injections must be stopped if toxic manifestations such as

albuminuria, rashes, whether erythematous or purpuric, or stomatitis, develop. Disease of the heart, liver, or kidneys is a contraindication to gold therapy, tests of renal function should always precede treatment.

Treatment by Drugs—The eucylates are less effective in controlling pain in rheumatoid arthritis than is the case in rheumatic fever, but even so aspirin in 10 gr doses, especially if combined with 5 gr of phenacetin or medinal, may give considerable relief. Supposed intestinal antiseptics, such as salol and guaiacol, are of no value. The patient is usually anæmic and iron should be given in full doses.

General Management—An essential point in the treatment of rheumatoid arthritis is the prevention of deformity. This object is best obtained by ensuring that the joints are kept in satisfactory position during the acute stage of the disease. To avoid wrist drop and foot drop, suitable splints must be applied, and it is most important to prevent the knees becoming fixed in a position of flexion. The blood sedimentation rate should be estimated at intervals, as a fall in the rate is an indication of improvement. The most valuable guide as to the activity of the disease is tenderness on pressure over the affected joints. So long as this persists, rest is indicated, but all the affected joints should be gently moved through their full range once every day to prevent the formation of adhesions. When the joint is no longer tender, active movements and massage must be instituted. If deformities such as wrist drop have occurred, no attempt should be made to improve the position of joints by forcible movement, either with or without an anæsthetic, until local tenderness has disappeared. Any manipulation of joints which are actively inflamed is likely to lead to a serious exacerbation of symptoms.

The problem of the restoration of function in joints deformed by rheumatoid arthritis is mainly one for the orthopædic surgeon. Even in cases which appear hopeless, great improvement may result. It must be realised that to a certain extent rheumatoid arthritis is a self limited disease, the activity of which tends to die out in the course of years, even if completely untreated. In chronic cases a great deal of disability is due rather to lack of function than to organic changes in the joints, and provided there are no signs of active disease, vigorous re education is advisable. Only too often chronic cases of rheumatoid arthritis are allowed to lie in bed as permanent incurables, whereas active and passive movements, combined with encouragement, will often enable the patient to get about.

Massage, active and passive movements, radiant heat, diathermy, local application of hot paraffin wax, whirlpool and foam baths may all help to accelerate recovery and to restore tone to the wasted muscles

The outlook in rheumatoid arthritis is certainly less gloomy than it was twenty years ago, mainly owing to the realisation of the importance of focal infection, improved orthopædic treatment better physiotherapeutic measures, and gold therapy In dealing with patients suffering from the disease, it is essential, though often difficult, to maintain an atmosphere of optimism

Still's Disease—This is a rare disease occurring in children usually starting between the ages of three and six It is characterised by a multiple arthritis, which in its characteristics is similar to rheumatoid arthritis There is also a general enlargement of lymph glands and an enlarged spleen The disease runs a prolonged course with exacerbations and remissions The cause of Still's disease is unknown but it is thought to be infective

ANKYLOSING SPONDYLITIS

Ankylosing spondylitis, or, as it is sometimes termed, *spondylose rhizomélisque*, is a relatively uncommon disease Its incidence is almost entirely confined to males and its onset is commonly between twenty and thirty years of age The main changes are found in the spine and sacro iliac joints, but sometimes the hip and shoulder joints are involved subsequently

Nothing is known of the origin of the condition, and there is little evidence that eradication of focal infection is beneficial From a pathological point of view the chief changes are osteoporosis of the bodies of the vertebræ and calcification of the ligaments of the spine, particularly the lateral and interspinous ligaments This results ultimately in a completely fixed spine which gives a characteristic X ray picture, often described as a "bamboo spine" (*vide* Plate 29) It is a striking contrast to the *osteoarthritic spine* (*vide* Plate 30) In the latter there is muchipping of the bodies of the vertebræ and no calcification of the ligaments The spine is usually kyphotic, and in advanced cases the chest becomes fixed, owing to bony ankylosis of the costo vertebral articulations

The symptoms of ankylosing spondylitis are pains in the back, spreading down to the arms and legs, striking limitation of movement, and later deformity of the back with varying degrees of limitation of movement in the hips The condition



PLATE 29—Ankylosing Spondylitis Advanced stage showing 'bamboo spine' calcification of ligaments, osteoporosis of spine and obliteration of sacro iliac joints
 (From *The Rheumatic Diseases* by Francis Back M.D. Cassell 1935)



PLATE 30—Spondylitic Osteoarthritis, showing Flipping of the Bodies of the Third and Fourth Lumbar Vertebrae and Normal Sacrospinous Joints.
(From *The Rheumatic Diseases* by Francis Bach M.D. Cassell 1935)

is usually slowly progressive over a number of years, and ultimately the patient may succumb to intercurrent respiratory infection

Treatment is often unsatisfactory, but sometimes deep X ray and gold therapy will arrest the disease. Attempts must be made to prevent gross deformities, and during exacerbations complete rest in a good position is essential. Remissions occur, the disease sometimes becoming arrested spontaneously

FIBROSITIS AND MYOSITIS

The importance and frequent occurrence of inflammatory conditions in the connective tissues and in the muscles has only been fully recognised in recent years. They account for the enormous numbers of cases often loosely termed muscular rheumatism, chronic rheumatism, lumbago, neuritis, and pleurodynia. The essential feature is a localised chronic inflammatory process which occurs most commonly in the fascia and muscular attachments and which in some cases is secondary to focal infection or metabolic disorder. The onset of symptoms often appears to be precipitated by exposure to cold and wet, hard or unaccustomed muscular exertion, and fatigue

Fibrositis occurs mainly in middle and later life, and may affect practically any part of the body. One of the most frequent sites is the lumbar fascia and the attachments of the lumbar muscles, when the condition is usually described as lumbago. Although pain in the lower back is usually due to fibrositis, there is evidence that in some of these cases the symptoms are due to herniation of the nucleus pulposus (*vide* p. 944). This is specially likely to be so in cases of acute lumbago, where the patient, apparently in perfect health is suddenly struck down with a paroxysm of agonising pain in the small of the back, which renders movement impossible

A similar condition in the muscles of the neck produces torticollis. When the intercostal muscles are affected, there is pain on taking a deep breath or on movements of the thorax (pleurodynia). Fibrositis of the upper portion of the trapezius may produce brachial neuritis. As a rule there is little or no impairment of general health and no pyrexia. The sedimentation rate remains normal

Treatment is twofold. In the first place, it is important to search for evidence of focal infection and to take immediate steps for its eradication, secondly, the pain can often be

relieved by local treatment to the affected tissues. Radiant heat, hot baths, and diathermy are all valuable as palliatives, though they do not as a rule produce a permanent cure unless the original focus of infection is dealt with.

During the more acute phases there is some degree of spasm in the muscles of the affected area, but when relaxation occurs, localised nodules can often be felt on deep palpation. These are very tender on pressure, though the surrounding muscle may be insensitive. In order to facilitate the detection of such nodules, the overlying skin should be thoroughly heated with an infra red lamp, which induces muscular relaxation. Vigorous rubbing and kneading of the nodules must be carried out until their dispersal is complete or they may be injected with novocaine. Postural errors should be corrected, and any fibrositic adhesions causing pain or preventing normal movements should be broken down by manipulation.

It is important to bear in mind that pains resembling muscular rheumatism may occur as symptoms of a more serious underlying condition. Thus, for example, spondylitis or malignant disease of the spine may, for a time, be misdiagnosed as fibrositis. Whenever symptoms do not improve or disappear within a few weeks it is essential to reinvestigate the patient thoroughly.

Myositis Ossificans—This rare condition is characterised by intramuscular ossification. It usually follows acute or chronic trauma or occupational strain of certain muscle groups, and occurs most commonly in the muscles of the thigh, and in the upper arm. Ossification has been reported in muscles and tendons in association with tabes dorsalis and syringomyelia. Even without interference myositis ossificans following trauma shows a marked tendency to retrogress and ultimately disappear.

DISEASES OF BONES

Osteitis Deformans—This condition is often known as Paget's disease. The onset is very gradual and symptoms seldom arise before middle life. The striking features are a progressive enlargement in the circumference of the head, together with a symmetrical thickening and bowing of the long bones, more particularly the femur and tibia. The increase in the size results from formation of new bone beneath the periosteum. The disease is often associated with arteriosclerosis, but nothing is known of its causation.

Headache is a frequent symptom and there is sometimes pain and tenderness in the affected bones, which are liable to fracture with slight trauma. The disease is slowly progressive and is not in itself fatal, though death is liable to occur from intercurrent infections and from sarcomata arising in the affected bones. No treatment appears to modify its course.

Osteogenesis Imperfecta—This rare condition is congenital, with a tendency to occur in families. Survival to adult life is unusual. The disorder is primarily nutritional, and the bones, particularly the long bones, are unduly fragile, the cortex of the bone is thin and deficient in calcium. Spontaneous fractures are the most prominent symptom and lead to marked deformity and shortening of the limbs. Often there is a blue colouration of the sclerotics. There is no treatment beyond the exercise of care in avoiding trauma. If the patient reaches adolescence spontaneous improvement occurs.

Osteomalacia—This disease is almost confined to the female sex and usually occurs between the ages of twenty and thirty. It is often associated with pregnancy, defective hygienic conditions and an unsatisfactory diet are also predisposing causes.

The bones affected are the long bones, spine, ribs, and pelvis. The amount of vitamin D in these is much diminished, and as a result the bones are softer and more fragile than normal. Spontaneous fracture is common, and this may be the first obvious symptom of the disease. In advanced cases great deformity results from the softness of the bones, this is specially true of the pelvis, in which the sacrum is pushed downwards as the result of the weight of the body, while the acetabula are driven inwards by the heads of the femurs.

The course of osteomalacia is very variable, but the disease is usually progressive, and death eventually results from intercurrent respiratory infections. Further pregnancies should be avoided, and a diet rich in calcium and phosphorus should be taken. Cod liver oil is sometimes beneficial.

Multiple Myelomatosis—In this rare condition the bone marrow is invaded by multiple neoplasms of sarcomatous type. Spontaneous fractures are very common. In many of the cases the urine contains Bence-Jones protein. This can be demonstrated by heating the urine, when the temperature reaches about 50° C, the protein coagulates with the formation of a turbid precipitate. If the heating is continued to the boiling point the coagulated protein becomes redissolved.

Achondroplasia—This disease originates during foetal life and affects mainly the bones which develop from cartilage.

Those most commonly involved are the long bones, the pelvic bones, and the base of the skull. Growth is stunted, and achondroplasiacs who reach adult life are seldom over 4 ft in height, the legs and arms are very short in comparison with the development of the trunk, the face appears small, but the cranial vault is normal in size. Although the bones are short and bowed, they are strong and do not fracture readily. Intelligence is normal, and the subjects of the disease often live in good health to an old age. The fingers tend to be equal in length. Treatment is ineffective.

Hypertrophic Pulmonary Osteo-arthropathy.—This cumbersome name is given to the condition of "clubbing" in the fingers and certain bony changes which occur in bronchiectasis, empyema, chronic phthisis, and congenital heart disease.

Clubbing of the fingers is very common in all the above-mentioned conditions, and a similar change also occurs in the toes. The terminal phalanx is swollen and often somewhat cyanosed, the finger nail is curved, and at the base of the nail the skin has a shiny, tense appearance. In marked cases the tips of the fingers are expanded in both their antero-posterior and lateral diameters. The clubbing is nearly always symmetrical, though a few cases of unilateral clubbing have been reported. X-ray examination shows no obvious change in the bony structure of the terminal phalanges.

In addition to clubbing there is occasionally enlargement of the bones of the extremities, particularly of the hands and feet, and sometimes osteoarthritic changes in the joints. Whereas clubbed fingers are very common, the fully developed condition of pulmonary osteoarthropathy is exceedingly rare. Whether the changes are due to interference with tissue nutrition, which result from prolonged venous congestion, or whether there is some specific toxæmia remains undecided.

Generalised Osteitis Fibrosa Cystica is discussed under Disorders of the Parathyroid (*vide p. 277*).

J. J. CONYBEARE

DISEASES OF THE NERVOUS SYSTEM

THE GENERAL SYMPTOMATOLOGY OF ORGANIC NERVOUS DISEASES

THE central nervous system, enclosed within the bony framework of skull and vertebral column is inaccessible to direct observation, hence, with the exception of the head of the optic nerve which lies open to view in the fundus of the eye, the nervous system cannot be investigated by the clinical methods of inspection, palpation, or percussion, upon which we so largely depend in the diagnosis of diseases of the thoracic and abdominal viscera. Therefore the recognition and clinical localisation of disease within the nervous system depend upon the observation and interpretation of signs of disordered activity in tissues innervated by this system. In short the diagnosis of nervous diseases is more largely a matter of applied anatomy and physiology than is the case with diseases of other systems.

THE FUNCTIONAL REACTION OF THE NERVOUS SYSTEM TO DISEASE

The activities of any part of the nervous system which is directly involved in a focus of disease or injury may be disordered in either of two ways. They may be diminished or abolished on the one hand, or they may be stimulated to an excessive degree on the other. Thus a lesion of the cerebral motor cortex may by destruction of nerve cells produce motor paralysis, or by stimulation give rise to a focal or Jacksonian convulsion. Both effects may be combined, a focal fit being followed by motor weakness. It is usual to speak of the two orders of symptoms so produced as *paralytic* and *irritative* respectively. Again, while the nervous system shows a high degree of local specialisation of function, yet

normally it acts as a whole, and damage to any one part of it may be followed by disorder of function in regions left untouched by disease. Such disorders may be said to be indirectly produced and like those directly caused are of two orders. For example, when a hæmorrhage occurs within a cerebral hemisphere and tears up the pyramidal fibres as they course down through the internal capsule, the direct result of the lesion is a hemiplegia. But there is also a sudden loss of consciousness which may persist for some days. A predominant part in the production of this coma is played by "shock" or diasthesis, the functions of both cerebral hemispheres being temporarily abrogated on the sudden development of a gross destructive lesion within their substance. This shock passes off all parts of the cerebrum resuming activity except that actually destroyed by the hæmorrhage, while the direct result of the destruction, the hemiplegia, remains as a more or less permanent residuum.

But the hemiplegia at first flaccid, in course of time becomes spastic, that is, the muscles which have lost voluntary power begin to develop an excessive tonus, show exaggerated tendon reflexes and the phenomenon of clonus. In certain circumstances they may even develop involuntary movements. All these phenomena indicate an excessive activity of parts of the nervous system not destroyed by the lesion, but rather released from a control normally exercised over them by the neurones now destroyed. Thus there are four groups of symptoms of disordered action of the nervous system —

Directly produced	{ "Paralytic" symptoms "Irritative" "
Indirectly produced	{ "Shock" " "Release" "

It will be readily appreciated that of these, symptoms due to shock and irritation tend to be transient, while those resulting from destruction or release may persist indefinitely. In many chronic nervous diseases such as paralysis agitans, residual hemiplegia and double athetosis, release symptoms may be in the forefront of the clinical picture, paralytic manifestations taking the second place.

There are other factors governing the impairment or dissolution of function in diseases of the nervous system to some of which we may summarily refer. Thus acutely produced lesions are apt to cause more intense and extensive disorders of function than similarly localised and extensive lesions

of gradual development. Again when a high grade function is undergoing dissolution from the action of a disease process, its most recently and finely developed aspects are earlier and more severely impaired than its older and simpler components. Thus in residual hemiplegia the isolated and skilled movements of the fingers are more severely impaired than the simpler movements in the proximal parts of the upper limb, and recover less rapidly and completely than the latter. Again in that complex motor function, articulate speech, the power of expressing thought in a foreign language may be lost in an individual who retains this power in his native tongue. Similarly, a comparable graded dissolution of sensory function may result from appropriate cerebral lesions.

Again, we cannot regard the central nervous system as entirely independent of the other tissues of the body. Its activity is for example, delicately responsive to variations in the quality and quantity of its blood supply. The nerve cell in particular is extremely sensitive to oxygen deprivation, being stimulated at first and then paralysed as the oxygen supply drops below normal. The convulsions of asphyxia and those which may accompany sudden profuse hæmorrhage into the peritoneal cavity are examples of the hyperexcitability developed by the cell at a certain level of oxygen starvation. The coma which ensues indicates abolition of function from more severe oxygen want. It is probable that the Jacksonian fits produced by compression of the cerebral motor cortex, either by a tumour or by a depressed fragment of bone owe their origin to vascular disturbances of this kind and not to direct mechanical stimulation of the cortex.

THE STRUCTURAL REACTION OF THE NERVOUS SYSTEM TO DISEASE

In what is primarily a clinical account of nervous diseases the structural reaction may be very briefly described. The complete nervous system may be regarded as consisting of vascular, supporting, and parenchymatous elements. In a given case of nervous disease any one of these may be primarily affected, the others being secondarily involved, and the resulting lesion will be the combined reaction of all three to the pathogenic agent. Thus a primary parenchymatous degeneration will be followed by a secondary glial proliferation and by a phagocytic activity of certain glial elements.

SYMPTOMS OF DISEASE OF THE MOTOR SYSTEM

The motor system may be taken to consist of three main components (1) the pyramidal or upper motor neurone extending from the cerebral motor cortex to the anterior horn cells of the opposite side of the spinal cord, (2) a complex group of extra pyramidal neurones, comprising numerous masses of grey matter in the cerebral hemispheres and in the brain stem with the fibre systems arising in them and extending in one or more links to the ventral horn cells of the cord, and (3) the lower motor neurone, which includes the motor nuclei of the cranial nerves and the anterior horn cells of the spinal cord.

The last named is the "final common path" to the skeletal muscles and upon it play the upper motor and extra pyramidal systems of neurones, and also the central ends of the afferent limbs of the spinal reflex arcs.

The Upper Motor Neurone may be regarded as the sole path for the conduction of volitional motor impulses and as exercising control over the extra pyramidal motor system; therefore damage or destruction of this neurone has a dual effect. There is an impairment or loss of voluntary movement, a directly produced phenomenon, and an increase of muscle tone and of tendon reflexes with a qualitative change in the plantar response. The latter are release phenomena and result from the uncontrolled activity of extra pyramidal motor mechanisms which still continue to play upon the lower motor

(Reference to Fig. 16)

The cerebrospinal or pyramidal tract (Pyr) arises in the cerebral motor cortex and traversing the internal capsule and brain stem decussates in the medulla oblongata. It then runs downwards in the lateral white column of the spinal cord, its fibres terminating in the grey matter of the anterior horn. The vestibulo-spinal tract (V.Sp.T) arises in the vestibular nucleus (V.N.) and runs downwards through the medulla and the anterior white column of the spinal cord, its fibres terminating in the grey matter of the anterior horn. The rubro-spinal tract (R.Sp.T) arises in the red nucleus (R.N.) in the midbrain, decussates at its level of origin and traverses the lateral part of the pons and medulla and the lateral column of the spinal cord, its fibres ending like those of the tracts already enumerated in the anterior horn in association with the anterior or ventral horn motor cells.

The cerebellum sends efferent fibres from its dentate nucleus (D.N.) to the crossed red nucleus through the superior cerebellar peduncle, the cerebello-rubral tract (C.R.T.).

A short projection system arises in the globus pallidus of the lenticular (lentiform) nucleus (L.N.) and passes to the red nucleus, the striato-rubral tract.

These various efferent paths other than the pyramidal tract form the best known components of the extra pyramidal motor system and all of them including the former exert influence upon the lower motor neurone (the anterior or ventral horn cell and its axon).

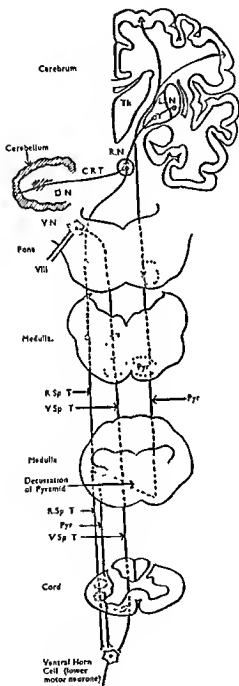


FIG. 16.—THE CENTRAL MOTOR PATHS.

neurone The condition of spastic paralysis resulting from disease of the upper motor neurone is seen in its fullest expression in residual hemiplegia The loss of voluntary movement in hemiplegia affects unilateral movements only, and these unequally Thus in the upper limb, which is usually more affected than the lower, movements of the fingers and hand are most impaired In the leg the movements of dorsiflexion and of flexion are more profoundly impaired than those of plantar flexion and extension In the face, the movements of the lower half are alone involved while the tongue is protruded towards the paralysed side The trunk muscles commonly escape, as do the movements of deglutition and mastication

The hypertonus or spasticity as it is sometimes called, also has a selective incidence developing in the flexors and adductors of the upper and in the extensor and plantar flexors of the lower limb Thus the spastic arm goes into flexion and adduction, the spastic leg into extension and adduction When spasticity is sufficiently developed not only are the tendon jerks increased but patellar and ankle clonus may be present Also under certain conditions involuntary tonic spasm invades the muscles leading to changes of attitude in these, which are spoken of as 'associated reactions' Finally the normal reflex movement of plantar flexion of the hallux on stroking the sole of the foot is replaced by one of dorsiflexion the so-called extensor or Babinski response This response is accompanied by reflex contraction of all the limb flexors which in certain cases of paraplegia may develop into a powerful flexor spasm of the limb The abdominal reflexes also disappear in upper motor neurone lesions In lesions of the spinal cord involving both pyramidal tracts a condition of spastic paraplegia results

The Extra-pyramidal Motor Neurones—These include the corpus striatum red nucleus substantia nigra, and other deeply seated masses of grey matter in the brain and the short and descending paths arising in them The characteristics of disease of this complex system are an absence of true paralysis and the presence of disturbances of muscle tone (Parkinsonian rigidity) and of involuntary movements (athetosis, tremor, choreiform movements) In uncomplicated lesions of this system the reflexes undergo no qualitative change The most familiar example of an extra pyramidal symptom complex is paralysis agitans or Parkinson's disease

The Lower Motor Neurone—When this neurone is destroyed

by disease the skeletal muscle is cut off from all functional connection with the nervous system. There is a degree of paralysis proportionate to the degree of denervation, a loss of reflex muscle tone and of the tendon reflexes, followed by muscular atrophy which may proceed to complete loss of contractile substance in the affected muscles in which secondary fibrosis and deformity finally ensue. In addition, the electrical excitability of the muscle alters and finally disappears (Reaction of Degeneration, Total Loss of Excitability).

The Cerebellar System—Although, strictly speaking, this system should be included amongst extra pyramidal motor mechanisms, it is usual to deal with its symptomatology separately. The essential clinical result of a loss or impairment of cerebellar activity is the development of a gross disturbance of co-ordination in voluntary movement, the so-called cerebellar ataxy, and hypotonia. There are no true paralyses and no qualitative changes in the reflexes. A description of these disturbances of movement will be dealt with under the appropriate heading (*vide p 771*).

SYMPTOMS OF DISEASE OF THE AFFERENT NERVOUS SYSTEM

The afferent nervous system includes *sensory* and *non-sensory* components. The latter, which is not less important than the sensory component, includes the afferent limbs of numerous reflex arcs. The grey matter in which lie the synapses of these arcs is situated at all levels of the spinal cord and brain stem, and the impulses which traverse the arcs do not influence consciousness. The spinal arcs subserve the tendon reflexes and certain reflex movements which underlie the co-ordination of movement. The long arcs which pass up to the brain stem are predominantly concerned in the maintenance of muscle tone and in the regulation of posture. The spino-cerebellar tracts form part of this non-sensory afferent system. The loss of muscle tone and of tendon reflexes, which are amongst the cardinal signs of *tabes dorsalis*, depend upon a lesion of certain of these non-sensory afferent fibres as they lie in the root entry zone of the posterior white columns of the cord. Disappearance of the tendon reflexes, when not due to paralysis of the muscle concerned, depends upon an interruption of the afferent limb of the arc either in the mixed peripheral nerve, the posterior spinal root, or in the intramedullary part of the latter as it lies in the posterior column of the cord.

The Sensory System, like the motor system, consists of a chain of neurones extending from the periphery to the highest sensory centres in the thalamus and cerebral cortex.

The mixed peripheral nerve contains fibres underlying every aspect of sensibility, both cutaneous and deep, hence impairment or loss of all modes of sensation follows a peripheral nerve lesion, and localisation of the lesion depends upon the determination of the topography of the area of altered cutaneous sensibility. The view that cutaneous sensibility is made up of epicritic and protopathic elements can no longer be maintained, and indeed, the fine investigations needed to determine the sensory phenomena formerly believed to reveal the presence of these two elements are far too complex for routine clinical examination. We may therefore consider the cutaneous sensory loss resulting from a peripheral nerve lesion under the headings of tactile, painful, and thermal sensibility, and the deep sensory loss under those of pressure and pain sense and the sense of position. In addition the localisation of touch the discrimination of two simultaneous contacts (compass test), and the appreciation of size and shape are sensory functions that may also have to be considered.

The Central Sensory Paths—On reaching the spinal cord the sensory fibres undergo a regrouping according to the modes of sensibility they subserve, and travel up in the cord in special paths. Thus impulses underlying tactile sensibility and the sense of position travel up in the original peripheral neurone in the uncrossed posterior white column as far as the posterior column nuclei of the medulla oblongata, here they end and the second sensory neurones arise, crossing the midline as the arcuate fibres in the decussation of the fillet (sensory decussation) and then turning upwards as the medial fillet to traverse the pons and midbrain and end in the thalamus. The fibres carrying impulses underlying painful and thermal sensibility end in the posterior horns of the side on which they enter the cord, the second neurone crossing the midline to travel up through cord and brain stem in the lateral regions of both, to reach the thalamus with the medial fillet. We thus have uncrossed and crossed sensory paths in the cord, and in the brain stem two sensory paths, now both crossed, which finally meet in the lateral nucleus of the thalamus. Here the sensory path undergoes a final rearrangement. Impulses underlying the affective aspects of sensibility, particularly pain and thermal sensibility, pass to the essential nucleus of the thalamus, where it is possible that they reach consciousness to

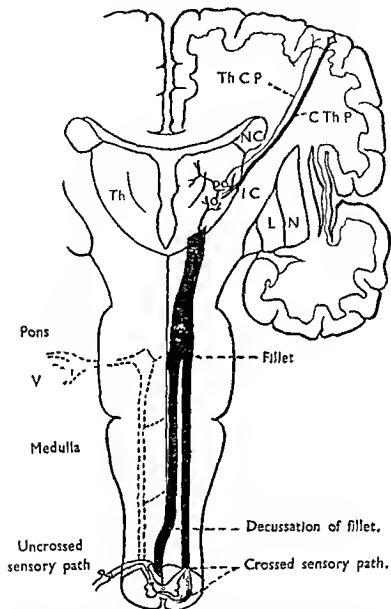


FIG 17—THE CENTRAL SENSORY PATHS

The uncrossed sensory path runs up in the posterior white column, its fibres terminating in the posterior column nuclei of the medulla oblongata, and the next system of neurones decussates at once in the sensory decussation of the fillet. The crossed sensory path runs up to the thalamus in the lateral columns of the cord and in the lateral part of the brain stem to the thalamus where, with the fillet, it terminates in the lateral nucleus. The thalamo cortical path (Th C P) and the cortico thalamio path (C Th P) connect the thalamus and sensory cortex. The thalamic path passes from the lateral nucleus of the thalamus to the main sensory nucleus of that structure, where it is probable that the affective aspects of sensibility reach consciousness. (After Head and Holmes.)

Th = thalamus IC = internal capsule L N = lenticular (lentiform) nucleus.
V. = the fifth nerve and its sensory nuclei

form the basis of the corresponding sensations. Those underlying tactile sensibility, localisation, two point discrimination and appreciation of size, shape, and texture, in other words the discriminative aspects of sensibility, pass to the cerebral sensory cortex which is situated mainly in the post central convolution.

• In general, a cerebral or brain-stem lesion involving the sensory pathways produces a crossed hemianæsthesia. In the case of cortical lesions, thermal and painful sensation are little if at all affected and the characteristic disturbance is an inability to localise cutaneous stimuli, especially tactile stimuli and a defective appreciation of the size, shape, and texture of objects held in the affected hand (astereognosis). The characteristics of sensory loss from lesions at lower levels within the central nervous system will be dealt with under the appropriate headings.

Inco-ordination of Movement—The disorders of voluntary movement known as ataxy, or inco-ordination require brief mention here, as they arise in one of two ways. In lesions of the cerebellum or of the cerebellar fibre system, a form of ataxy may develop which has been mentioned above as cerebellar ataxy. This ataxy is not dependent upon any disturbance of the sensory nervous system, and is not aggravated when the patient is deprived of vision.

On the other hand, any lesion in spinal cord, brain stem or cerebral hemispheres which interrupts the sensory impulses conveying the sense of position and the appreciation of movement will produce what is known as a sensory ataxy. Perfect co-ordination requires accurate information from the muscles as to their degree of contraction and thus as to the position of the limbs, trunk, and head. If this information be not forthcoming control of movement is impaired or lost and ataxy results. The lack of this information may be compensated in a great measure by vision but if the patient's eyes be closed this compensation is lost and the maximal degree of disorder of movement is produced. The most familiar example of a sensory ataxy of this order is seen in tabes dorsalis where the sensory fibres underlying the relevant forms of sensibility are degenerated in the posterior columns of the spinal cord. When the lower limbs are the seat of this disorder, the typical tabetic ataxy of gait and stance results, and is aggravated when the subject shuts his eyes, a procedure which is the basis of Romberg's test.

In the case of the upper limbs the contrast between the two forms of ataxy, cerebellar and sensory, is not so readily observed.

The so called intention tremor of the arms is an example of the former variety, and is not aggravated when the subject's eyes are shut. When the patient is asked to touch his nose with his finger with his eyes closed, the limb deviates on its way, but reaches the nose correctly. In the sensory ataxy of tabes however, the sense of position of the limb being impaired, the subject's hand wanders and fails to reach the desired objective unless the aid of vision be forthcoming.

ELECTRICAL REACTIONS OF MUSCLE

A healthy muscle in normal functional connection with the nervous system responds by contraction when its motor nerve is stimulated by the faradic (interrupted) or the galvanic (continuous) current. The muscle fibres themselves are responsive to the make and break of the continuous current but are inexcitable by the interrupted current. The situation at which the application of the stimulating electrode in both forms of current gives the maximal response is the point at which the motor nerve enters the belly of the muscle, the so called "motor point". The faradic current is obtained from an induction coil and when applied in sufficient strength provokes a muscular response which persists during the passage of the current. The response to the galvanic current on the other hand is restricted to the moments at which the current is made and broken.

The galvanic response consists therefore in momentary muscle twitches when the current is made and broken, or, in other words, when the circuit is closed and opened. Either cathode or anode may be used as stimulating electrode, and the relative potency of the four stimuli thus made possible is expressed by the formula $KCC > ACC > AOC > KOC$, where KCC represents the cathodal closing contraction, ACC the anodal closing contraction, AOC the anodal opening contraction and KOC the cathodal opening contraction. Thus it follows that the minimal effective current is that which evokes a KCC alone. These differences are called the polar reactions. Abnormalities in electrical reaction may consist in simple quantitative alterations in excitability or in qualitative changes. Thus general hyperexcitability to both forms of current is found in tetany, while hypoeccitability or loss of excitability to both forms of current is present in disuse atrophy of muscles and in the muscular dystrophies.

In lower motor neurone lesions qualitative changes are found. When a muscle is denervated and the motor nerve fibres have

degenerated, the *reaction of degeneration* is present. This consists in a loss of excitability to the faradic current and in an altered response to the galvanic current. Of this alteration to the galvanic current the essential features are a lowering of the threshold of stimulation and a peculiar sluggishness of contraction which is readily visible, the contraction wave some times passing slowly along the muscle. A less constant and less readily distinguishable feature is the altered polarity of the response, ACC being now greater than KCC. This reaction (R D) appears in the third week after motor nerve section, and persists as long as contractile muscle fibres remain in the paralysed muscle. Various degrees of partial reaction of degeneration are seen in incomplete interruption of motor nerves. It is not often that an investigation of the electrical reactions of a muscle affords information not obtainable by other methods, but in the case of facial palsy (Bell's palsy, *q. v.*, p. 889) these reactions are of great prognostic value. The presence of faradic response in the second and third weeks indicates the probability of early recovery of function, but the presence of R D indicates complete denervation and the probability of delayed recovery. The electrical reactions are normal in upper motor and extra pyramidal lesions.

THE REFLEXES IN DIAGNOSIS

The clinical study of the reflexes is of the greatest possible importance in the diagnosis of nervous diseases, for while considerable disturbances of motor and sensory function may, as in the numerous clinical pictures of hysteria, coexist with a nervous system free from discoverable disease, qualitative alterations in the reflexes invariably mean organic disease of this system, and in the initial stages of many such diseases diagnosis may turn entirely upon the state of these reflexes.

Apart from gross structural changes, however, variations in the reflexes may occur as transient phenomena in certain intoxications and during *epileptiform seizures*.

The reflexes which are of importance clinically fall into three groups—the tendon reflexes (tendon jerks), the cutaneous reflexes and the Babinski or "extensor" type of plantar response.

The Tendon Jerks are true spinal reflex reactions and are present in all healthy persons. Under emotional stress, in the psychoneuroses and in some debilitated persons, they may undergo a general increase in briskness, but in these circumstances all the tendon jerks in upper and lower limbs and on

both sides are equally affected. An increase in the tendon reflexes in a single limb or in the limbs of one side invariably indicates organic disease. In some normal individuals the tendon reflexes in the upper limbs may be difficult to elicit, while in small children and aged persons a similar difficulty may attend the attempt to obtain an ankle jerk. But with this exception the knee and ankle jerks should always be obtainable. "Reinforcement" may be necessary to elicit them, and this is achieved by asking the subject to clench his fists or to make a sustained and forceful voluntary contraction of muscles not under investigation for the reflexes. In disease of the upper motor neurone, the tendon jerks undergo considerable increase, and the phenomenon of clonus may develop in spastic legs, ankle clonus when the foot is dorsiflexed by the examiner, and patellar clonus when the patella is depressed forcibly. In lesions of the lower motor neurone the tendon jerks are diminished or abolished in the affected muscles. In slight lesions this change may be the most striking physical sign, appearing before there is much muscular weakness or wasting. A similar change is seen in muscular diseases, *e.g.*, in muscular dystrophy.

A selective change in certain tendon reflexes may have a localising value in focal lesions of the spinal cord. The segmental localisation of the tendon reflexes employed clinically is given in the following table —

Biceps brachii	5 6	Cervical segments
Triceps	6 7	" "
Supinator (Brachioradialis)	7 8	" "
Knee	2 4	Lumbar
Ankle	1 2	Sacral

The Cutaneous Reflexes employed in clinical examination are the epigastric and abdominal and the cremasteric reflexes. These generally disappear in all lesions of the upper motor neurone at levels higher than that of their segmental spinal localisation, persisting unchanged in lower motor lesions unless the muscles engaged are themselves paralysed. In healthy persons stroking the sole of the foot evokes a plantar flexion of the great toe, the so-called "flexor" or normal type of plantar response. This also is a cutaneous reflex and, like those mentioned above, disappears in lesions of the upper motor neurone, being, however, replaced by a new type of plantar response which is not strictly a cutaneous reflex, although commonly described as such.

The Extensor or Babinski Type of Plantar Response which

replaces the normal or flexor type of plantar response is a physical sign of the utmost importance in clinical diagnosis. When present as a permanent phenomenon it invariably indicates structural change in the pyramidal system of fibres that is, in the upper motor neurone. It may in any given case be the only unequivocal sign of such change, but even when thus occurring as an isolated abnormality its significance is unmistakable. As we have mentioned, it may occur transiently in epileptiform seizures (in eclampsia, uræmia, epilepsy, Jacksonian fits), and in certain intoxications without associated convulsions (delayed chloroform poisoning, acute yellow atrophy of the liver, cholæmia and inconstantly in morphia, hyoscine and barbiturate poisoning).

The most striking feature of the reflex response is a dorsiflexion of the great toe, generally with an associated dorsiflexion and fanning of the other toes. There is also, however, a constant reflex contraction in all the limb flexors. This may be so slight as to require palpation for its detection, or so violent (in certain severe paraplegias) as to constitute a powerful flexion spasm of the whole limb. The response is most easily and constantly elicited by stroking with the tip of the finger or with the point of a pencil *the outer margin of the sole*. In conditions of severe spastic paralysis of a leg, however, it may be obtained by pricking or pinching the skin almost anywhere over the whole limb and also by pressure over bones and muscles over a similarly wide area. Therefore the response is not strictly plantar or purely cutaneous. It is homologous with the nociceptive flexion reflex in the hind limb of the spinal animal (Sherrington).

THE CEREBROSPINAL FLUID

The cerebrospinal fluid is secreted by the choroid plexuses of the lateral third and fourth ventricles. It leaves the ventricular system by way of the foramina of Majendie and Luschka (median and lateral apertures) in the roof of the fourth ventricle and passes into the basal cisterns of the subarachnoid space. Thence it flows through the opening between the tentorium and the brain stem up over the cerebral hemispheres, and also through the foramen magnum into the spinal theca. Finally, it is absorbed into the blood stream. Thus it reaches by means of tiny villous processes which arise in the arachnoid in the neighbourhood of the dural sinuses. The villi cross the subdural space and penetrate the fibrous dural walls of the sinuses, projecting into the lumen. It is possible that some

absorption may occur in a similar manner in the spinal sub-arachnoid space, but the main channels lie in the skull

The main function of the fluid is probably mechanical, namely, that of providing a water cushion for the brain and spinal cord. It may also carry off degeneration products which flow into it from the perivasoular spaces of the brain. It is probable that when secreted it contains neither cells nor protein these being added to it in the course of its circulation.

Composition—It is a clear, colourless saline fluid, on lumbar puncture it is found to be under a pressure of from 60 to 150 mm of water. The total quantity is approximately 130 c.c. As obtained from the theca it contains from 2 to 5 lymphocytes per cubic millimetre, 0.025 to 0.03 per cent protein, 0.05 to 0.08 per cent glucose, and 0.7 per cent chlorides. Of the protein content albumen predominates, being always in excess of the globulin fraction, even when both are increased under pathological conditions. The pathological changes characteristic of various diseases are described under the appropriate headings.

Changes may occur as the result of an altered secretion by the choroid plexuses and in this respect the fluid follows very closely the composition of the blood plasma. But a fluid which is normal on secretion may be altered as it circulates in the sub-arachnoid space, and it is with such an alteration that we are concerned in acute leptomeningitis.

DISEASES OF THE CEREBRAL MENINGES AND HYDROCEPHALUS

The cerebral meninges may be the seat of inflammatory processes or of new growth formation, the former being the more common, especially in the case of the pia arachnoid. It is probable, however, that tumour development in the meninges is not so rare as was formerly supposed. The so-called meningioma of the brain arises from arachnoidal cells lying in the substance of the dura mater while infiltration of the pia arachnoid by glioma, sarcoma, and secondary carcinoma also occurs, such infiltration is frequently microscopic and gives rise to symptoms resembling those of meningitis.

PACHYMEINGITIS

True inflammation of the cerebral dura mater is comparatively rare. In the presence of suppuration in the bones or sinuses of the skull a pyogenic pachymeningitis may develop

When infected from without in this way the dura presents a very resistant barrier to the passage of organisms to the underlying brain, and an extra-dural abscess may form. However, infection may reach the subarachnoid space and the brain by way of venous channels which traverse the dura, or even by perforation of this membrane. In these circumstances an acute leptomeningitis or a cerebral abscess forms, and the local dural reaction becomes of minor importance. Gummatous pachymeningitis may also complicate syphilitic lesions of the skull.

Chronic Subdural Hæmatoma (*Pachymeningitis Hæmorrhagica Interna*)—The condition to which this name is applied has been regarded as inflammatory in origin but it is practically certain that it is always traumatic and the result of venous oozing into the subdural space. It is therefore more accurately named chronic subdural hæmatoma.

Ætiology—The condition was formerly supposed to be a primary inflammation of the dura mater, non infective, and of obscure origin, and specially prone to occur in chronic alcoholic and demented subjects and in general paralytics. The common absence of any history of head injury in the cases was regarded as excluding a traumatic factor. However, it is clear that the subjects of the diseases named are those most likely to sustain minor head injuries and least likely to be able to recall them to memory.

The essential lesion appears to be the tearing of the small veins which pass from the arachnoid to the dura mater on their way to the venous sinuses which lie in the latter. Relatively trivial jarring blows on the head, not necessarily of a degree of violence productive of concussion, are most likely to produce the venous lesion in question. The veins once injured slow and intermittent oozing leads to the gradual development of a subdural hæmatoma. A subdural hæmatoma may be the immediate result of a severe head injury which necessarily comes under observation and treatment from the outset. We are not here concerned with this type of subdural hæmatoma, but only with that which follows apparently trivial injuries that receive little or no treatment and may not even come under observation. This chronic variety of hæmatoma reveals its presence after a latent period of varying length by symptoms suggestive of a progressive space-occupying lesion. It is with this that the present chapter deals.

Morbid Anatomy—A collection of blood, often very large is found situated beneath the dura over the convexity of the cerebral hemisphere and extending from the frontal to the

occipital lobes, but seldom passing farther laterally than the Sylvian fissure (lateral sulcus). It is commonly bilateral, though not invariably so. The blood is encapsuled in a membrane which is loosely attached to the overlying dura, and may receive a free vascularisation from this source. The deep surface of the cyst is lightly adherent to the subjacent pia arachnoid. On its internal surface the membrane is rough from adherent clot. The contained blood is tarry and liquid in long-standing cases, and the enclosing membrane may be discoloured by it. The state of the blood and the thickness of the cyst wall vary with the age of the lesion. It is probable that the cyst is formed by organisation of the peripheral clotted portion of the blood.

Symptoms—The history of a fall on the front or back of the head is frequently to be obtained. This may have been apparently trivial and not followed by any immediate consequences. Prodromal symptoms appear after a varying interval of from a week to two or three months. Headache and slight mental change are the most constant of these. The headache may be constant and severe, and may be referred to the site of the injury, there may be associated vomiting. Gradually apathy, drowsiness, and forgetfulness develop, and there may be "fainting attacks." Physical examination may be negative at this period, and neuro syphilis or some mental disorder may be diagnosed. When these symptoms have been present for some four or six weeks they may suddenly become severe. Intense headache and vomiting with sudden coma may develop, only to pass off in an hour or two, returning again after an interval of days. Focal symptoms are often absent, or when present are variable in their appearance. Evidence of bilateral compression of the cerebral hemispheres ultimately develops hemiparesis muscular spasticity, bilateral loss of the abdominal reflexes, Babinski plantar responses, and optic neuritis. Once these signs are established the condition grows steadily worse, and unless treated the patient lapses into coma and dies. The pulse is often slow even in the early stages of the condition.

Diagnosis—In the presence of a history of apparently slight head injury, the premontory period of vague and transient headaches and mental change, the appearance of definite stupor or coma after some weeks, and the variable appearance of the signs mentioned above, together present a very characteristic clinical picture, of which the very fluctuation of the signs and symptoms is one of the most striking features. Confirmatory evidence may occasionally be obtained by lumbar puncture, the cerebrospinal fluid being sometimes faintly tinged with

usually most intense at the base of the brain, but as the exudate increases it tends to spread laterally along the Sylvian fossa and fissure (lateral sulcus) on to the convexity of the hemispheres, where it lies in the hollows between the convolutions, spreading in all directions from the Sylvian fissure. In non-suppurative tuberculous meningitis the spread of infection and the development of tubercles follow the same lines. Changes of the same order occur in the superficial layers of the brain underlying the meninges, namely, serous exudation, minute hæmorrhages and small foci of encephalitis and hyperæmia.

The Cerebrospinal Fluid—The acute meningeal reaction reveals itself not only in the structural change noted above but also in alterations in the composition of the cerebrospinal fluid. The nature and severity of the meningeal reaction may be determined from the examination of the cerebrospinal fluid and therefore the procedure of lumbar puncture is a diagnostic method of the greatest value in acute meningitis.

The essential features of the meningeal reaction as betrayed by this fluid are as follows: the cellular content is greatly increased, polymorphonuclear cells predominating in a suppurative meningitis, lymphocytes in the non suppurative tuberculous form. The protein content is raised, and a coagulum may form in the fluid on standing. The glucose level falls and sugar may disappear, while the chloride content undergoes diminution. Finally, the organism concerned may be found. On lumbar puncture the fluid usually escapes under pressure. Excess of cells may render the fluid opalescent, while in suppurative meningitis it becomes purulent.

Symptoms—The essential clinical features of acute meningitis are remarkably constant though variable in intensity from case to case. They consist of intense headache, pain in the back, with rigidity of the spine. There is a characteristic combination of irritability with drowsiness, passing on to terminal coma. The patient lies on his side in an attitude of flexion and in a stuporous condition becoming irritable and refractory when disturbed. There may be accesses of restlessness requiring restraint, and periodical inarticulate cries. Retention of urine is a common and sometimes a very early phenomenon, and should always be looked for. Examination may fail to reveal any appreciable alterations in the reflexes or in the motor system, and focal signs of this order may be absent throughout the course of the case. This is especially so in acute and rapidly fatal infections.

In meningococcal and tuberculous meningitis, where the duration of the illness may be longer, cranial nerve palsies (squint, pupillary anomalies), papilloedema, variations in the tendon reflexes and signs of hemiparesis may develop, but are not essential components of the meningeal reaction. In tuberculous meningitis the knee and ankle jerks may become sluggish, and disappear, sometimes relatively early in the course of the illness.

One or both of the following phenomena are usually present. *Kernig's Sign*, which consists in a reflex spasm of the hamstrings when the leg is passively flexed at the hip with the knee extended, and *Brudzinski's Sign*, which is a sudden flexion of the arms and legs when the head is passively flexed. It would be wrong to suppose that these signs are in themselves conclusive. They must be considered in connection with the body of clinical evidence in any given instance.

Pneumococcal Meningitis commonly complicates a pneumococcal infection elsewhere in the body, but may be primary in the subarachnoid space. The cerebrospinal fluid is purulent, and may be too thick to flow through a lumbar puncture needle. It contains an abundance of polymorphonuclear leucocytes, and the organism is also found. The condition develops rapidly and coma soon supervenes.

Pyogenic Meningitis—The streptococcus and the staphylococcus are the organisms most commonly present, and usually reach the subarachnoid space from septic foci elsewhere. The state of the cerebrospinal fluid resembles that found in pneumococcal meningitis, staphylococci or streptococci being found in abundance. The presence and nature of the primary infective focus in cranial sinuses, middle ear, or elsewhere, indicate the origin and character of the meningeal infection.

Meningococcal Meningitis (Cerebrospinal Fever) is described on p. 60.

Syphilitic Meningitis is dealt with under the heading of Neurosyphilis (*vide* p. 846).

Treatment—The general management of the case consists in keeping the patient in a cool and darkened room. Iced applications to the head and venesection, or the use of leeches, are sometimes employed. The relief of pain calls for the use of such drugs as phenazone or aspirin, but morphia may be required. Until the recent introduction of chemotherapy with drugs of the sulphonamide group, acute meningitis was except in the meningococcal variety, virtually always rapidly fatal. Now many, though not all, lives are saved by early

oral administration of one or other of the drugs of this group. The scheme of treatment described in the case of cerebrospinal fever should be followed in other varieties of suppurative meningitis (see p. 66). The repeated lumbar punctures for draining cerebrospinal fluid formerly in vogue are now scarcely necessary. For severe headache, however, they may be of value and should then be used as circumstances indicate.

Symptomatic treatment only is available in the case of tuberculous meningitis, *e.g.*, the relief of headache by drugs (aspirin with or without codeine gr. $\frac{1}{4}$ to 1 with each dose of aspirin) or by thecal drainage by lumbar puncture.

Diagnosis.—The recognition of the presence and nature of an acute meningitis may be one of the most difficult of all diagnostic problems, because several acute general infections may be accompanied by symptoms like those of meningitis ("meningism") as an incident in their course. This is the case in typhoid, pneumonia, acute tuberculosis, and also in acute poliomyelitis. In these circumstances lumbar puncture and examination of the cerebrospinal fluid is called for to provide the necessary diagnostic information. It was taught by Jenner that whereas in a true meningitis headache and delirium may co-exist, in the meningism of other infections headache disappears if delirium ensues. In true suppurative meningitis a turbid or purulent fluid containing large numbers of polymorphonuclear cells and the responsible organism will be found. In tuberculous meningitis a clear fluid in which a coagulum forms on standing, and in the meshes of which the tubercle bacillus may be found, and the presence of a pure lymphocytosis are diagnostic. In acute poliomyelitis a clear fluid with a lymphocytosis and normal glucose and chloride contents is common, although polymorphonuclear cells are often present. In meningism the fluid is normal.

Finally, the signs and symptoms of the primary infection, both in cases of meningitis and in those of acute infections with meningism, will help to a correct diagnosis.

HYDROCEPHALUS

Any pathological process that interferes with the absorption of the cerebrospinal fluid will cause it to accumulate within the ventricles and to distend them. In infants this distension leads to separation of the cranial bones at their sutures and to enlargement of the skull, a condition known as internal hydrocephalus.

It is theoretically possible for an excess of secretion over an absorption of normal degree to produce a similar state of affairs, but actually hydrocephalus is always due to impaired absorption.

Such an interference with the return of the cerebrospinal fluid to the venous system may arise in any of the following circumstances in the case of congenital anomalies of the ventricular system such as atresia of the aqueduct of Sylvius (cerebral aqueduct), or absence of the foramina of Majendie and Luschka (median and lateral apertures of the fourth ventricle), the blocking of the latter foramina by some pathological lesion, or any block in the subarachnoid space which prevents the fluid from reaching the channels of absorption above the tentorium.

Cases of internal hydrocephalus have been divided into congenital and acquired. The former are due either to such a congenital anomaly as has been mentioned, or to an intra-uterine meningitis with formation of adhesions. There is reason to suppose that both processes occur.

Acquired internal hydrocephalus results either from a meningitis in which the formation of adhesions has blocked the foramina in the fourth ventricle, the basal cisterns, or the opening in the tentorium. Cerebral tumours are another cause of internal hydrocephalus when they are so placed within the skull or brain that they block the ventricular outlet either at the foramina of Monro (interventricular foramen) in the lateral ventricles, at the aqueduct in the midbrain, or at the foramina of the fourth ventricle.

Most cases of hydrocephalus, if we include patients of all ages, are due to meningitis. Even during the brief course of tuberculous and pneumococcal meningitis, signs of acute hydrocephalus may develop, but in the case of meningococcal meningitis the patient may survive with permanent hydrocephalus. The internal hydrocephalus associated with tumour may modify the clinical course of the case, masking localising symptoms or aggravating the condition of increased intra-cranial tension caused by the tumour. In such circumstances a fatal issue is not long delayed, except in the rare instances of successful extirpation of the offending tumour and a restoration of normal conditions within the skull.

Morbid Anatomy—In congenital hydrocephalus evidence of congenital anomaly or of meningitis may be found, but in most instances a routine examination of the brain gives no information as to cause. The development of the cerebral hemispheres is always grossly defective, and their walls may

be reduced to a membrane which is translucent. The skull is increased in size, and may measure over 30 in circumference at birth, and the cranial vault may be reduced to the thinness of paper. The form of the skull is also altered, the frontal eminences bulging and the orbital plate being depressed.

In acquired internal hydrocephalus the rigidity of the skull prevents the extreme degree of ventricular distension and skull enlargement seen in the congenital variety. Examination of the brain generally reveals the causative lesion, either an old meningitis or a tumour.

Symptoms—The extreme size of the skull in congenital hydrocephalus may render the delivery of the living child impossible, but such a child once successfully delivered may show progressive enlargement of the skull. In extreme cases it may be possible to transilluminate the skull which is thin and soft. Mental and physical impairment of all degrees from complete idiocy and physical disability to mild mental defect and little or no physical defect may be seen. Either mental defect or symptoms of spastic paralysis may exist alone.

In acquired hydrocephalus symptoms of disordered function of the nervous system predominate changes in the form of the skull being absent or moderate in degree. These symptoms are those of increased intracranial tension—headache, vomiting, impairment of vision, and convulsions. The long continued distension of the ventricles produces motor and sensory disorders due to cerebral compression, motor disorders predominating. These are of the nature of a bilateral spastic weakness with the corresponding alterations in the reflexes. Percussion of the skull in children with hydrocephalus resulting from intracranial tumour may yield a "cracked pot" note. When tumour underlies the condition, death inevitably ensues.

In certain congenital and acquired (meningitic) cases the process is not progressive, and when arrest occurs before the onset of serious mental or physical disability the individual may lead a comparatively normal life.

Treatment—Surgical procedures and repeated lumbar puncture have so far proved fruitless in all varieties of internal hydrocephalus. From what has been said of the pathogenesis of the condition it follows that purely symptomatic measures are all that are available, namely, the relief of headache and the control of convulsions and such physiotherapeutic measures as may alleviate the motor disabilities.

THE LOCALISING SIGNS OF DISEASE OF THE BRAIN

The various ways in which a lesion may disturb the functions of the nervous system have been enumerated and described, and it follows from what was said on this subject that the nature as well as the localisation of the pathological processes may be expected to play a part in determining the character of the symptom complex. Actually in those chronic and slowly progressive lesions which underlie the bulk of affections of the nervous system, the situation of the lesion is the determining factor in the production of the symptoms. However, in certain acute diseases and injuries of the brain, irritative and shock symptoms may appear, and their nature is largely determined by that of the pathological process, but apart from special circumstances of this kind paralytic symptoms dependent upon the situation of the lesion are the rule. The following details may be given of the localising signs of disease of the brain —

In general, we may say that the more rapid the development of a focal lesion the greater the disturbance of function to which it gives rise. Conversely, a slowly developing lesion may be completely masked for a long period by the development of functional compensatory activities in undamaged regions of the brain. Thus a gunshot wound of the cerebellum produces immediately a gross disturbance of cerebellar functions, while a slowly growing tumour in this situation may reach a considerable size before unequivocal signs of cerebellar disease develop.

Again the period at which localising signs appear is of importance in assessing their value. Those which develop early have definite localising value. On the other hand, the steady rise of intracranial tension which accompanies the *growth of a tumour within the skull causes widespread compression* and resulting defect in the circulation, and hence in the function, of regions of the brain remote from the tumour. In this way "false localising signs" may be produced late in the course of the malady. Paralysis of the external (lateral) rectus muscle is an occasionally observed sign of this order. The abducens nerve in its course forwards to the orbit, passes over the edge of the petrous bone, making a sharp turn at this point. With a high degree of intracranial tension the contents

of the posterior fossa of the skull, the cerebellum, and brain stem tend to be forced downwards towards the foramen magnum, and in consequence the nerve is stretched tightly over the sharp edge of the bone, and conduction along its fibres is interrupted. On the other hand, a sixth nerve palsy ushering in the clinical picture of a cerebral tumour indicates direct involvement of the nerve by the tumour, and thus has localising value.

THE SIGNS OF LOCAL LESIONS IN THE CEREBRAL HEMISPHERES

Lesions involving those cortical areas which stand in close functional relationship with the projection fibre systems—motor, sensory, and visual—give rise to recognisable localising signs. There are, however, large cortical association areas which are silent in the sense that disease within them produces no focal symptoms, yet in the presence of general indications of a brain lesion this absence of focal symptoms may itself be of localising value as indicating the involvement of a "silent area" of the hemisphere.

The Frontal Lobes—Lesions at the frontal poles are frequently very difficult of recognition. The characteristic localising symptoms are mental and emotional changes. The patient becomes silent, apathetic, and lacking in initiative. Memory, judgment, and association of ideas are poor, and as a direct result of this mental state the subject becomes indifferent to the calls of nature and passes urine and faeces wherever he may be. With extensive lesions, dementia and a condition of stupor may develop. Rarely, when there is pressure upon the olfactory bulb, there are anosmia and a feeling of irritation in the nose which leads the patient to rub his nose constantly. In certain instances the patient becomes talkative and embarrassingly facetious and holds grandiose ideas.

The Motor Area—The excitable motor cortex occupies the ascending frontal convolution (precentral gyrus) and the hinder ends of the frontal convolutions immediately anterior. Topographically, the movements of the foot are represented at the upper end of the motor cortex, those of the leg, trunk, upper limb, hand, neck, face, lips, and tongue in that order as we follow the convolution laterally to its lower extremity (Fig. 18). Focal or Jacksonian fits commonly begin in one of three foci—the angle of the mouth, in the thumb and index finger, or in the hallux, according to the region of the motor cortex

stimulated by the lesion. Such a fit begins as a clonic convulsion in one or other of these three foci. It may remain confined to this focus, or the convulsion may spread to adjacent parts and may finally involve all the musculature of one side, or become generalised throughout the skeletal musculature. In the latter case, consciousness is lost,

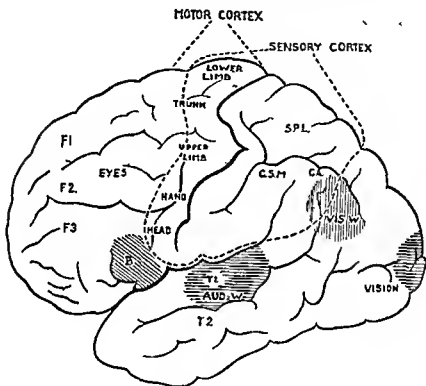


FIG 18—CORTICAL LOCALISATION

The lateral aspect of the left hemisphere. The motor area extends over the ascending frontal convolution (precentral gyrus) and the cortical region immediately anterior to it. At the posterior end of the second frontal convolution (middle frontal gyrus) is a region in which eye movements are represented. Both this and the motor cortex proper are indicated by stippling. The sensory cortex is more extensive and includes the ascending parietal (postcentral gyrus), superior parietal, and angular (inferior parietal) convolutions (after H. Head).

At the foot of, and anterior to, the ascending frontal convolution, is the so-called motor speech centre, Broca's convolution (B).

In the first temporal convolution of the left hemisphere is the auditory word centre (Aud. W.) and in the angular gyrus the visual word centre (Vis. W.).

The visual cortex just extends on to the lateral aspect of the hemisphere at the occipital pole.

but in localised convulsions perfect consciousness may be retained

The spread of a Jacksonian fit shows an ordered march from its focus in accordance with the topographical representation of movements in the motor cortex. A transient paralysis of the convulsed part usually follows the fit.

An uncommon form of Jacksonian fit arising in this region of the cortex consists in transient powerlessness of a limb or part of a limb without convulsive movement.

Although movements of the eyes are not represented in the motor cortex proper but in a cortical region lying anterior to it irritative lesions of the motor region may produce in association with rotation of the head a conjugate deviation of the eyes away from the side of the lesion. Lesions extending deeply into the substance of the hemisphere in this region may cause hemiplegia with marked spasticity.

The Sensory Area—This has its focus in the postcentral convolution, but embraces the surrounding cortex anteriorly, posteriorly, and laterally. The essential features of sensory change from a cortical lesion are (1) the relative integrity of sensibility to pain and temperature but a diminished power of differentiating various intensities of stimulus, (2) impairment of localisation of tactile stimuli a greater degree of defect in the discrimination of two simultaneous contacts, and (3) a still greater impairment of the power of recognising the shape size and texture of objects held in the hand. With this last defect goes an inability to identify objects held in the hand (astereognosis). There is in short a defect in spatial recognition and this is liable to lead to disturbances in co-ordination in the affected hand and digits. It is possible that Jacksonian fits which are preceded by subjective sensations in the affected part originate in this area of the cortex.

The Occipital Lobe—The visual function is represented in the cortex surrounding the calcarine fissure (postercaraine sulcus) on the medial aspect of the occipital lobe (vide Fig. 18). The right half of each visual field is represented in the left occipital cortex the left halves in the right cortex. Further, central vision is represented at the tip of the occipital pole, peripheral vision at the anterior end of the visual area the upper part of the field below the calcarine fissure and the lower part above this. Irritative lesions of the visual cortex produce a visual aura in which the subject sees formless and moving coloured lights, often accompanied or followed by a transitory

hemianopia Destructive lesions of one occipital cortex will produce blindness of the crossed halves of each visual field (homonymous hemianopia) while partial lesions of one cortex may produce quadrantic hemianopia. It is characteristic of the blind retinal quadrants in occipital lesions that when a point of light is thrown upon them the pupil reacts whereas in hemianopia resulting from lesions of one optic tract the pupil does not react on illumination of the blind part (Wernicke's hemianopic pupil reaction)

Temporal Lobe—Perhaps the commonest localising sign in tumours of this region is a crossed homonymous hemianopia due to involvement of the fibres of the optic radiation which curve round the inferior horn of the lateral ventricle on their way to the occipital cortex. Also in lesions of the left temporal lobe slight paresis of the crossed lower face may occur associated with a defect of the speech function of the kind known as word deafness (see p. 805). Irritative lesions cause a Jacksonian fit (uncinate fit) in which olfactory and gustatory hallucinations are associated with a transient dimming of consciousness known as a dreamy state. Sometimes also visual hallucinations of a complex order occur.

Internal Capsule, Thalamus, and Corpus Striatum—Hemiplegia is the characteristic expression of involvement of the anterior limb of the internal capsule. hemianæsthesia and hemianopia of involvement of the posterior limb. The hemianæsthesia involves all forms of sensation. Lesions in this situation may also encroach upon the lateral nucleus of the thalamus. When the latter is predominantly affected the hemiplegia tends to be transient, sensory symptoms and involuntary movements of the affected limbs persisting. All forms of sensation over the opposite half of the body may be affected but in the case of partial lesions the sense of position is the most profoundly affected form of sensibility. In certain cases the thalamic syndrome may be present. In this in addition to sensory loss there is spontaneous pain on the affected side of the body with a peculiar over reaction to painful or unpleasant sensory stimuli.

The Brain Stem—This part of the brain from midbrain to medulla contains structures of three orders. (a) *long projection paths* sensory and motor both of which are crossed that is have undergone decussation and run on the side of the brain opposite to that of the body which they innervate. (b) *cranial nerve nuclei* which are uncrossed, and (c) *association nuclei and reflex centres* which lie in the dorsal or tegmental part of the brain stem. Lesions of the brain stem may give

rise to symptoms due to lesions of all or any of these three groups of nervous mechanisms. A characteristic feature of focal brain stem lesions is a crossed hemiplegia or hemianæsthesia, with a cranial nerve palsy (of lower motor neurone type) on the same side as the lesion. Thus as we pass down the brain stem the motor cranial nerves successively involved on the side of the lesion will be the third, sixth, seventh, and twelfth. The particular nerve involved will indicate whether the lesion be in the midbrain, pons, or medulla. A lesion in the crus cerebri will produce a homolateral third nerve palsy, and a crossed hemiplegia, a lesion in the ventral region of the pons, a homolateral facial palsy and a crossed hemiplegia. Similarly, cranial nerve palsies may be associated with crossed hemianæsthesia. Lesions in the dorsal or tegmental portions of midbrain or pons will produce defects of vertical and lateral movement of both eyes respectively. Lesions in the midbrain involving the third nerve and red nucleus and superior cerebellar peduncle will produce a corresponding squint and diplopia, with involuntary movements and ataxy of the opposite side. Focal lesions in the medulla commonly prove rapidly fatal.

Cerebellum—Gross inco-ordination of voluntary movement without considerable weakness or qualitative alterations in the reflexes are typical of lesions of this part of the brain. In acutely produced lesions there is also marked flaccidity (atonia) of the musculature, but this is apparently not a constant feature of the symptom complex known as cerebellar ataxy. The form assumed by this ataxy naturally varies with the particular clinical test employed to demonstrate it. Thus a variety of so called components of cerebellar ataxy have been described, which for the most part have no independent existence apart from these empirical tests. The best known are as follows.

Atonia, a marked flaccidity and undue extensibility of the muscles as revealed by manipulation of the limbs. This, when unilateral, may be an early and valuable localising sign in cerebellar abscess at a time when ataxy of movement is slight or inappreciable. *Nystagmus*, with a slow coarse movement on looking to the side of the lesion, and a rapid, finer movement on looking away from the side of the lesion. This abnormality of ocular movement is often associated with a difficulty in conjugate deviation of the eyes, more marked towards the side of the lesion. *Adiadochokinesis*, or an inability to perform rapidly alternating (e.g., pronation supination) movements, when the single movement can be normally performed. The disability here arises from a spread of innervation to muscles

produce symptoms in virtue of (1) the disorders of pituitary function with which they may be associated, (2) the compression and deformation of the optic chiasma they produce, and (3) increased intracranial tension. These phenomena are considered under the heading of Intracranial Tumour (see p 774)

INTRACRANIAL TUMOURS

For clinical purposes we may include under this heading all tumours that, encroaching upon the cranial cavity and increasing its contents, produce disorders of brain function either by compression or destruction of the brain, or by both combined. Such tumours may arise in bone in the meninges, or within the brain substance. They may be of the nature of true neoplasms or they may be granulomata. Of the former class some are primary within the skull while others are metastatic, the primary growth being situated elsewhere in the body. The brain is one of the commoner seats of tumour formation in the body.

Ætiology.—Nothing certain is known of the genesis of tumours of the brain or its coverings, although microscopic examination will suffice to tell from what element a tumour has arisen. Here, as in other organic diseases of the nervous system injury has been invoked as an adequate exciting cause of tumour formation. It is manifestly difficult to establish a relation between head injury and the subsequent appearance of a tumour, but on the whole it seems probable that in a few instances such an injury may excite the tissues to neoplastic activity. This is most clearly the case with the endothelioma.

Pathology.—(1) **GLIOMA** is the commonest variety of brain tumour, constituting about 40 per cent of all such tumours. Under this heading are included all growths which arise in glial elements. These differ greatly in macroscopic and in microscopic appearance, and in their rate of growth. The more the constituent cells of such a tumour differ from normal glial cells in appearance the more malignant in character is the growth. All are infiltrating tumours arising within the brain substance. Among the types which have been differentiated, the following are the most commonly encountered: (i) *Glioblastoma*, a richly cellular rapidly growing tumour leading to death within a few months, (ii) *Medulloblastoma*, a rapidly growing metastasising, cellular glioma commonly growing in the cerebellum in childhood, (iii) *Astrocytoma*, a diffuse infiltrating tumour which, since its margins are not

visible to the naked eye, is always very much more extensive than macroscopic examination suggests. Often only the central degenerated portions of the tumour are readily visible.

Though commonly thought to be single tumours all forms of glioma may be multiple, or may have several foci of active growth within the main tumour limits. No variety of glioma can be completely extirpated by the surgeon, and sooner or later recurrence is inevitable.

(2) **MENINGIOMA.**—This is also a common variety of intracranial growth. It arises in cells of arachnoid origin which lie in the meshes of the dura mater. It forms a firm, well defined mass rounded or nodular, and exerts its effects wholly by compression of the brain which it does not invade or infiltrate. Although it commonly grows inwards towards the subjacent brain, it may also develop outwards, when it invades the skull and may give rise to a superficial "boss" on the cranial vault which is visible from without. Common situations for the development of an endothelioma are the falx cerebri and the neighbourhood of the dural sinuses. It is usually a slowly growing tumour, and may give rise to focal symptoms before those indicating a general rise of intracranial tension.

(3) **PITUITARY TUMOUR**—Adenoma of the glandular portion (pars anterior) and tumour arising in the pituitary stalk (infundibulum) are the common varieties of new growth. Symptoms of three orders may follow their development: neighbourhood symptoms, signs of increased intracranial tension, and signs of glandular disorder.

Neighbourhood Symptoms—The posterior border of the optic chiasma lies on the diaphragma sellae and is compressed by tumours in or above the sella. The resulting symptoms are bitemporal hemianopia and primary optic atrophy, one eye being usually affected before its fellow (*vide* Fig 20, p 877).

Increased Intracranial Tension—This rarely develops except in the case of pituitary stalk tumours, when headache, vomiting and papilloedema are common.

Glandular Symptoms—The common adenoma (chromophobe adenoma) produces signs of hypopituitarism, obesity, regression of the sexual organs with amenorrhoea in women, and loss of sexual capacity in men. In chromophile adenoma an initial acromegaly or gigantism appears and later obesity and other signs of diminished pituitary activity may supervene. In stalk tumours signs of hypopituitarism are the rule.

(4) **AUDITORY NERVE TUMOUR**—A benign encapsulated

tumour may develop from the sheath of the eighth nerve, either as a solitary growth or as part of a generalised neurofibromatosis (von Recklinghausen's Disease). It is a fibroblastic tumour. It compresses successively the auditory, trigeminal and facial nerves, the cerebellum and pons, and ultimately gives rise to hydrocephalus and increased intracranial tension, with headache, vomiting, and papilloedema. Its symptomatology and the sequence of events in its evolution are indicated by the above list of structures involved.

(5) METASTATIC TUMOUR.—This is commonly carcinoma, secondary to primary growth in lung, breast, stomach, or prostate. Rarely, hypernephroma may be followed by secondary deposits in the brain.

Secondary carcinoma commonly gives rise to multiple nodules scattered throughout the brain, and also in some instances to a diffuso microscopic infiltration of the pia-arachnoid. It is the latter which gives to the clinical picture of secondary carcinoma of the brain the characteristics it usually shows: namely, an onset with mental symptoms (apathy, muttering delirium, and terminal coma), signs indicative of meningitis (pain and stiffness in the neck, cranial nerve palsies, convulsive seizures), and signs of tumour (papilloedema, headache, and vomiting). There may also be progressive loss of weight.

(6) TUBERCULOMA.—More common in children than in adults, this relatively rare lesion may occur in any part of the brain, but most frequently in cerebellum or brain stem. It is a rounded tumour, caseous at the centre, and marked off from surrounding tissue by a zone of hyperæmia. Operative attempts at the extirpation of tuberculoma are almost invariably followed by tuberculous meningitis.

(7) SYPHILOMA.—Gumma is a very rare tumour. It is important to remember that a positive Wassermann reaction in the serum of a subject presenting the signs of cerebral tumour by no means indicates that the tumour is of this nature, or that anti-syphilitic medication is an adequate method of treatment.

(8) BLOOD-VESSEL TUMOURS.—Rarely, venous or arterial angioma may occur on the surface of the cerebral hemisphere; and are sometimes associated with cutaneous nævi in the distribution of the homolateral fifth nerve: An angioma gives rise to Jacksonian fits, and when arterial to a cranial bruit and the signs of tumour.

Hæmangioma of the cerebellum also occurs and produces the signs of a tumour in this situation.

Symptoms.—These are of three orders *focal symptoms* due to disturbance of function in the brain region immediately involved, *general symptoms* which result from the general compression of the intracranial contents, and *epileptiform fits*, which cannot readily be placed in the first two categories and which will be referred to later.

In many cases the general symptoms of raised intracranial tension are the earliest to appear, focal symptoms appearing relatively late, sometimes indeed only as terminal phenomena. On the other hand, the signs of a slowly progressive local lesion may antedate the appearance of general symptoms of hypertension.

Both focal and general symptoms are for the most part due to compression rather than to destruction of brain tissue. As the cranial contents increase in bulk with the development of the tumour, first the cerebrospinal fluid and then blood are expressed from the skull. When the latter occurs, cerebral functions begin to fail. The so called localising signs are the expression of such an interference with the blood supply of the region of the brain immediately involved by the tumour. Thus, the Jacksonian fits which may accompany the development of a tumour in the region of the cerebral motor cortex are in this way produced since at a certain level of oxygen starvation the motor cells become hyperexcitable and discharge with the production of a focal convulsion.

General Symptoms—These are headache, sickness, failure of vision and a slowly developing blunting of mental acuity leading ultimately to stupor and coma. Not one of these symptoms is constant at least in the initial stages of the illness. *Headache* is perhaps the most constant, though not necessarily the earliest symptom. It is often complained of as most severe on waking from sleep and after physical exertion. It may occur in paroxysms of great intensity. Its situation has no certain localising value.

Vomiting—This is most frequent in cases with severe headache and other signs of great increase of intracranial tension. It is usual to speak of so called "cerebral vomiting" as not associated with preceding nausea and as projectile in character. These characters are by no means invariable, and the undue stress laid upon them has frequently led to a failure to recognise the significance of vomiting in the early stages of cerebral tumour.

Failure of Vision is due to what is spoken of as papilloedema that is an oedema of the optic nerve head. As this develops the edges of the discs lose their definition and become hazy,

the disc becomes hyperæmic and reddish in colour. The physiological pit is obliterated and the lamina cribrosa disappears from view. The veins become distended and dark in colour. Gradually the whole disc and the immediately surrounding retina rise into a hemispherical mound in which the emerging vessels are buried, and on the surface of which white exudate and hæmorrhages make their appearance. Finally, the condition of "choked disc" is reached, and vision fails rapidly and may be lost. A secondary atrophy of the nerve fibres ultimately ensues, the disc shrinks again and becomes a white opaque object, with the traversing vessels entangled in organising exudate. The retina between the disc and the macula may become œdematous during the height of the neuritis and be thrown into tiny folds, spotted with exudate at their summits, and radiating from the macula to the disc in a fan shaped manner.

The failure of vision may be gradual, proceeding by an increasing peripheral constriction of the visual field, or it may be of dramatic suddenness. Once blindness has ensued, the pupils tend to dilate and to become immobile.

An inconstant indication of raised intracranial tension is a slowing of the pulse which may fall below 60 per minute. This is more commonly seen, however, in the presence of subdural hæmatoma or cerebral abscess than with tumour. As a terminal sign periodic breathing may make its appearance.

Fits—Generalised epileptiform fits indistinguishable from those of idiopathic epilepsy not infrequently occur during the clinical course of tumour of the brain. Such fits generally indicate the cerebral hemispheres as the site of the tumour, but have no more precise localising value. Their clinical importance lies in the fact that they may precede all other signs and symptoms, and may occur as the sole symptom over a period extending to several years. The onset of single fits, or of status epilepticus in a middle aged person who appears in other respects to be in normal health and has been previously free from attacks of the kind should always give rise to a suspicion of cerebral tumour. In short, it may be stated that such tumours frequently first reveal their presence in this way.

All the symptoms so far considered vary greatly in intensity from case to case. Any one or more may be absent and, as we have seen, all may fail except as terminal phenomena. They tend to be most intense in rapidly growing tumours and in tumours situated in the posterior fossa of the skull. On the other hand, they are minimal in very slowly growing

tumours and in aged persons. Cerebral tumours are commonest in relatively young and middle aged adults, and it is important to remember that the clinical combination of headache and vomiting which may precede any loss of vision (though not the optic neuritis which ultimately produces this) may be observed in individuals whose general state of health appears good and who do not seem seriously ill. As a result there is frequently a failure to appreciate the possibly sinister significance of this symptom complex, with a resulting neglect to examine the fundi of the eyes, and an unnecessary delay in reaching a diagnosis.

Focal Symptoms—The character of these has been dealt with in an earlier section. It has been pointed out that they may precede the signs of a general rise of intracranial tension, particularly in the case of slow growing tumours, and it may be said that the earlier they appear, the greater their localising value. Late in the course of intracranial tumour, when there are signs of a severe degree of general compression, focal signs may appear which have no localising value whatever, and may mislead the observer who does not take the time factor into account. The mode of production of one such "false localising sign," namely, sixth nerve palsy, has already been described.

In those cases in which a dangerous degree of cerebral compression develops in the absence of equivocal focal symptoms, mention may be made of a unilateral diminution or disappearance of the abdominal reflexes as indicative of a tumour of the opposite side of the brain.

The Cerebrospinal Fluid—On lumbar puncture the fluid may be found to be under considerable pressure (300 to 1,000 mm. water), but otherwise normal except in those cases where the tumour comes in contact with the fluid, either in the ventricles or at the base of the brain. In these circumstances a protein increase may be found.

Age Incidence—A word is necessary on this subject. Not only have the different histological varieties of tumour their favourite sites of incidence in the brain, but also characteristics of age incidence.

During the first ten years of life, medulloblastoma in the fourth ventricle is the common tumour. Its clinical picture includes the signs and symptoms of raised intracranial tension, unsteadiness of gait, and bilateral external rectus palsy.

In the second decade, pituitary stalk tumours frequently reveal their presence. In adolescents, this tumour often produces the signs of raised intracranial tension, papilloedema, headache and vomiting, together with signs of hypopituitarism,

but in adults primary optic atrophy and bitemporal hemianopia are the rule

Astrocytoma occurs at all periods of life, in the cerebellum in childhood, and here and in the cerebral hemispheres in adult life

Endothelioma, glioblastoma, and auditory nerve tumour occur in the middle and later periods of life

Diagnosis—The recognition of an intracranial tumour is perhaps, most difficult in those cases where focal symptoms are present and there is no evidence of compression of the cranial contents as a whole, that is, no papilloedema, headache, or vomiting. In such a case the organic origin of the focal signs having been determined on the grounds detailed in the introductory chapter to this section, it remains to ascertain whether a tumour is responsible for their appearance. The feature of most importance in this connection is a progressive development of the signs and indications of successive involvement of more functions (i.e. of expansion of the lesion). Thus, while a sudden onset of hemiplegia probably indicates a vascular lesion of the brain, a slowly developing hemiplegia especially if its progress be punctuated by focal or Jacksonian fits, is almost certainly due to tumour.

In respect of the general symptoms, especially where these exist without focal signs, we have to assess the significance of papilloedema, headache, and vomiting. The combination of vomiting and headache, with or without giddiness, especially in a subject who presents no clear indications of a gastric lesion or arteriosclerosis, should always lead the observer to suspect cerebral tumour and to examine the optic discs. Papilloedema may be present for a considerable time before there is any appreciable failure of vision and thus may have to be looked for. The diagnosis of tumour may present considerable difficulties when there is no other objective sign than papilloedema. The high degree of swelling of the discs associated with tumour is not seen in other conditions, but the lesser degrees of swelling and the associated hæmorrhage and exudate may closely resemble the neuro retinitis of renal or vascular disease. This also may give rise to headache, vomiting, convulsions, or coma. Therefore, in the absence of focal paralytic signs the possibility of renal disease must always be considered when papilloedema appears. Chronic lead poisoning may also produce a clinical picture resembling that mentioned above.

Abscess of the brain, which is in effect a fluid tumour and may be associated with considerable local cedema of

the brain, may also have to be considered. The presence or absence of chronic suppuration in the cranial venous sinuses, and particularly in the middle ear, should therefore be determined. A gummatous meningitis may give rise to a clinical picture resembling that of tumour, but in this condition the swelling of the discs is rarely extreme, or the impairment of vision gross, and such paralytic phenomena as are present are not severe except in the case of the cranial nerves. Nevertheless when the presence of a cerebral tumour is suspected, the diagnostic use of lumbar puncture is contraindicated if any high degree of compression of the brain obtains. The removal of cerebrospinal fluid allows the cerebellum to be forced downwards into a pressure cone in the foramen magnum, this in turn induces a dangerous compression of the brain stem with its contained vital centres, and may lead to rapid and fatal respiratory failure.

When localising signs are lacking, or even when the presence of tumour is suspected but cannot be confirmed, additional information may be obtained by one or other of the applications of radiography. A simple radiogram may reveal bony changes which indicate the presence and situation of the tumour, *e.g.*, deformation of the pituitary fossa in pituitary tumours, shadows cast by calcareous material in a slow growing tumour, lateral displacement of a calcified pineal gland, thinning of the skull, invasion of the skull by an endothelioma, or, in children, separation of the sutures.

When these fail to provide information the injection of air into the ventricles (ventriculography) may show dilatation or displacement of the ventricular system. The injection of air by lumbar puncture (encephalography) will reveal abnormalities of the cerebral sulci, and finally the injection of opaque substances (thorotrast) into the carotid artery followed by radiography will reveal displacements of the cerebral arterial tree. Ventriculography and encephalography are not wholly free from danger, while the resulting radiograms call for skilled interpretation. They are, therefore, best undertaken by the neurosurgeon under conditions that allow of immediate operation if any untoward reaction results. It is not necessary to describe the technique of these procedures here. Recently claims have been made that the electroencephalogram (see p. 866) may yield localizing information of value when this is not otherwise obtainable, but the results of this are not yet sufficiently reliable for much stress to be laid upon it here. It may be said, however, that simple clinical examination often fails to localise a new growth within the skull and that

the ventriculogram, expertly taken and interpreted, is not rarely necessary in the complete investigation of a suspected case of intracranial tumour

Course and Prognosis—When allowed to run their course, intracranial tumours almost invariably cause death. From the moment when diagnosis becomes possible life is rarely prolonged for more than a year. With increasing compression of the cranial contents the patient becomes blind, and finally comatose, dying of respiratory failure. The last named terminal phenomenon may occur suddenly from hæmorrhage into the tumour, or from some other cause of sudden rise of pressure within the skull.

Rarely, a tuberculoma will become inactive, or a glioma cease to grow, but these events are exceptional.

Treatment—There is no cure for intracranial neoplasm other than its removal by surgical operation. When it is possible to localise the growth, the attempt at its extirpation will depend upon anatomical and pathological factors. If it be by its situation accessible, is it of a kind that can be removed? The glioma, from its diffuse infiltrating character, clearly offers no prospect of complete removal, and the attempt may involve gross damage to brain tissue which is still functioning, and a corresponding degree of physical disability for the patient. The meningioma and neurofibroma, on the other hand, when accessible are favourable for complete or partial extirpation, and the best results have been obtained in cases of this kind.

When the tumour is inaccessible to the surgeon, irremovable from its character, or cannot be localised, palliative measures only can be adopted. These consist in the use of X rays or of radium applications to retard the growth of the tumour. None of these means can be relied upon to give a permanent result. The two symptoms which may call urgently for relief are headache and failure of vision. For headache analgesic drugs may be tried, but in extreme instances morphia may be required, and its use in adequate doses is amply justified. For impending blindness a decompressive operation offers the only hope of relief. This consists in the making of a free opening in skull and dura over the site of the tumour when this has been localised, or otherwise over the right temporal or parieto occipital regions. If such a decompression be not near the site of the tumour, the brain will tend to be forced through the bone defect, and considerable dislocation of tissue within the skull may result. Thus, while the relief of headache and the retention of vision may be obtained, the gradual

increase of the tumour and the dislocation of the brain produce severe physical disability, and the existence thus prolonged may become purely vegetative. Therefore in the case of unlocalisable or irremovable tumours decompression should scarcely be regarded as a routine measure of treatment, but reserved for cases of uncontrollable and intolerable headache, or for impending blindness in subjects whose general condition enables them to appreciate retention of useful vision. When the presence of an intracranial tumour has been diagnosed the possibility that it may be secondary carcinoma should be considered. The indications this may provide are described above (p 775).

CEREBRAL VASCULAR DISEASE

I ANATOMY

The frequency with which pathological changes in the arteries supplying the brain give rise to both acute and chronic disease of this organ makes a brief statement of some of the main anatomical features of the cerebral circulation essential.

Arterial blood reaches the brain by the two internal carotid and vertebral arteries.

The Vertebral Arteries enter the skull by the foramen magnum and meeting on the ventral surface of the brain stem join to form *the basilar artery* at the level of the lower border of the pons. This vessel continues upwards to the level of the convergence of the crura cerebri (cerebral peduncles) as they enter the brain stem and then divides into the two *posterior cerebral arteries* which at once sweep lateralwards round the crura to gain the inferior surface of the temporal and occipital lobes which they supply with blood, together with the marginal zone of the lateral aspect of these lobes.

From the basilar and vertebral arteries as they lie on the ventral surface of the brain stem, *performing and terminal* branches enter the medulla pons and midbrain. There also arise on each side of these arteries the three cerebellar arteries posterior inferior anterior inferior, and superior cerebellar which pass lateralwards and, giving off, perforating terminal branches to the brain stem as they traverse its surface end in a series of anastomosing branches on the cerebellar cortex.

The Internal Carotid Artery on each side enters the skull by the foramen lacerum, and passing upwards on the lateral

aspect of the body of the sphenoid bone reaches the neighbourhood of the posterior clinoid process and the optic chiasma. Here, after giving off the ophthalmic artery, which enters the orbit, it divides into three terminal branches, the middle and anterior cerebral arteries and the posterior communicating artery.

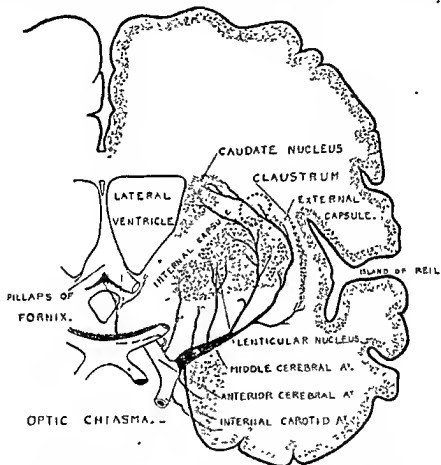


FIG. 10.—Coronal Section of the Left Cerebral Hemisphere, showing the central branches of the middle cerebral artery. The region of the lenticulo-striate artery, which is commonly the seat of rupture and of cerebral hemorrhage, is indicated by a circle of dots.

The *Middle Cerebral Artery* turns lateralwards from its point of origin, and as it traverses the anterior perforated space (substance) gives off its perforating or central branches, which pass deep into the region of the lenticular (lentiform) nucleus, internal capsule, and thalamus. The main trunk then enters the Sylvian fossa and finally emerges on the convexity of the

hemisphere at the anterior end of the Sylvian fissure (lateral sulcus) and near the foot of the fissure of Rolando (central sulcus) where it breaks up into cortical branches which supply all but the marginal zone of the lateral aspect of the hemisphere. One branch runs as far backwards as the occipital pole, where it is said to anastomose with branches of the posterior cerebral artery. The anterior cerebral artery runs forwards and towards the middle line dorsal to the optic nerve and, entering the great longitudinal fissure, comes to lie parallel to its fellow, to which it is joined by the anterior communicating artery. Both anterior cerebral arteries then sweep forwards round the genu of the corpus callosum and reaching its upper surface supply branches to the medial aspect of the hemispheres and to a narrow marginal zone of the convexity in frontal and parietal regions.

Lying in the subarachnoid space at the base of the brain are the origins of the three cerebral arteries, and with the communicating arteries they make up the circle of Willis (arterial circle).

II PATHOLOGY

The various forms of arterial disease have been described elsewhere (p. 567). All that need be said here is that the common types of pathological change found in the arteries of the brain are arterio-capillary fibrosis, atheroma, syphilitic endarteritis, and aneurysm. Apart from these lesions acute cerebral vascular disturbance may be produced by embolic occlusion of an artery, the primary seat of disease in this instance being remote from the brain.

Structural damage to the brain with associated disturbance of function arises when arterial disease leads to interference with the free supply of blood to any part of it. Such interference may arise from obliteration of the lumen of an artery, or from its rupture. In arterial occlusion, which may be due to pathological changes in the vessel wall or to blocking of a healthy artery by an embolus, the region of the brain rendered ischaemic softens and undergoes necrosis. In haemorrhage the effused blood tears up the brain at the site of rupture and compresses surrounding tissue.

1 Atheroma.—In elderly persons atheromatous changes in the arterial wall may lead to considerable distortion of the relatively thin-walled cerebral arteries, with narrowing of the lumen and localised thinning and dilatation. In these circumstances rupture followed by haemorrhage or thrombosis followed by cerebral softening is equally liable to occur.

In view of the distinctions often drawn between cerebral hæmorrhage and thrombosis it is important to emphasise that the antecedent factors are the same in each case, and that both accidents not uncommonly occur to the same individual

Rupture and Hæmorrhage in most cases occur on the lenticulo striate branch of the middle cerebral artery, particularly on the left side, with the result that this branch has been named "the artery of cerebral hæmorrhage" by Charcot. Whether the military aneurysms which stud the perforating branches of the middle cerebral artery are themselves the cause of rupture is disputed and it is thought that they may be normally present rupturing only when their walls are damaged by degenerative changes. Another not infrequent seat of rupture is one of the perforating branches of the basilar artery in the substance of the pons.

Factors tending to precipitate rupture are the cardiac hypertrophy and high blood pressure often found in those with diseased cerebral arteries. It follows from these pathological considerations that hæmorrhage is an accident of elderly persons being rare before the age of forty and increasing in frequency with each subsequent decade. A familial incidence is sometimes noticed. Occasionally in the young subjects of chronic interstitial nephritis with an associated high blood pressure and arterial degeneration, cerebral hæmorrhage may occur.

The effused blood, pouring from the ruptured lenticulo striate artery, tears up the white matter of the centrum semiovale and the corpus striatum and compresses the adjacent brain tissue. The blood may burst into the lateral ventricle or on to the surface of the hemisphere where it spreads over the convolutions beneath the pia arachnoid. Extravasations of blood may be of considerable size rendering the affected hemisphere larger than its fellow and producing flattening of the convolutions and local œdema of the brain surrounding the clot. In small hæmorrhages which the patient survives the clot shrinks and may be completely absorbed its place being taken by scar tissue or by blood stained fluid. At the periphery of the clot neuroglial proliferation leads to the formation of trabeculae which form a wall to the cavity.

On the other hand, when atheroma leads to *occlusion and cerebral softening* any of the main arteries of the brain or their branches may be involved although even here the middle cerebral and its central branches are most commonly affected. The result of infarction of the brain is to produce swelling and

serous effusion into the ischæmic region, which rapidly softens and within a few days is of creamy consistence. The softened area may be white or red, the latter when rupture of vessels at the periphery of the infarct has occurred. When the patient survives the necrosed tissue is absorbed and its place taken by a cavity, single or multilocular, filled with clear fluid.

2 **Hyperpiesia (Essential Hypertension) and Hypertensive Encephalopathy** The condition described under these names on p. 569 is not infrequently marked by the development of conspicuous but transient disorders of cerebral function. These are grouped together under the name of Hypertensive Encephalopathy.

Two forms of hypertensive attack have been described, one with and the other without signs of cerebral œdema.

(i) *With Cerebral Œdema*—This is said to occur in childhood, adolescence or early adult life. The subject may have essential hypertension without renal lesion or may have acute or chronic nephritis. A sudden rise in blood pressure is followed by headache, vomiting and drowsiness. There may be convulsions, or hemiplegia, or other signs pointing to some focal brain lesion. There is retinitis, sometimes with marked swelling of the optic discs, hæmorrhages, and exudate on the retina. Recovery may take place in a few days but the patient remains liable to recurrences, any one of which may terminate in fatal cerebral hæmorrhage.

(ii) *Without Cerebral Œdema*—The patient is commonly a middle aged or elderly subject with high blood pressure and the attack consists in the appearance and rapid disappearance of such focal signs as hemiplegia, aphasia, hemianopia, or focal convulsion. There is no swelling of the optic discs, but hypertensive retinitis is commonly present.

In both types when uncomplicated, there are no signs of renal inadequacy and the blood urea remains within normal limits.

In both types also spasm of the cerebral arteries has been invoked to explain the transience of what may be severe paralyzes. There is as yet no conclusive evidence on this point and sooner or later the subjects of hypertensive encephalopathy develop cerebral atheroma and succumb to cerebral vascular lesions.

Treatment—When signs of cerebral œdema are noted venesection and the administration of hypertonic saline are

indicated, 70 c.c. of the latter are given intravenously (15 per cent sodium chloride), or the same quantity of 50 per cent glucose solution. When the case is less urgent, $\frac{1}{2}$ oz. of magnesium sulphate in 6 oz. of water may be given per rectum and repeated as necessary.

3 **Syphilis**—The common syphilitic lesion of cerebral arteries is endarteritis obliterans, involving the central branches of the middle cerebral arteries, and less commonly the deep perforating branches of the basilar and vertebral arteries which supply the brain stem. Arterial occlusion and softening of the affected region of the brain are the results of this lesion. Not uncommonly other syphilitic lesions of the nervous system accompany endarteritis, namely, gummatous meningitis at the base of the brain, or tabes.

4 **Embolism**—In this condition the morbid process lies remote from the brain, somewhere between the pulmonary veins and the aorta. Possible sources of emboli are the vegetations on the mitral valve in endocarditis with mitral stenosis. More often, however, in this lesion clots may form in the auricular appendix (auricle), and fragments may be dislodged and carried off in the blood stream. Finally, in atheroma of the aorta tiny pieces of degenerated tissue or of thrombi may be detached and form emboli.

These emboli when they reach the cerebral circulation are commonly arrested, either in the main trunk or in one of the cortical branches of the middle cerebral artery, the left more particularly. Here they produce an infarct resembling in appearance and results the infarction of thrombotic occlusion. Occasionally the anterior and posterior cerebral and the vertebral arteries are the seat of embolic arrest, while very rarely the internal carotid may be blocked in this way. When this occurs the ophthalmic artery is also deprived of blood. It is clear that the disturbances of function produced by embolism are absolutely sudden in onset.

5 **Aneurysm**—It is preferable to deal with aneurysms of the larger cerebral vessels separately, as they may arise from a variety of causes. The circle of Willis (arterial circle) with the trunks arising from it and the basilar artery are the usual seats of aneurysmal dilatation. In the case of the last named vessel, syphilitic arteritis may be responsible, and the dilatation may reach such a size that the symptoms of tumour are produced. In the case of the other vessels, however, other causes than syphilis are more important. Thus it is thought that certain aneurysms on the circle of Willis may be congenital in origin, occurring at points of arterial junction and branching.

where the walls are thin from developmental defect. The arrest of an infective embolus may produce a local inflammation of the arterial wall with resulting sacculation. Finally, the atheromatous changes described above may produce aneurysms in these regions. In children and young adults these aneurysms are mainly congenital, but in elderly persons atheroma plays a larger role in their formation. In most instances these aneurysms do not rupture, and give rise to no symptoms during life. However, they may leak, or may burst with considerable effusion of blood and rapid death.

The blood thus effused spreads in the subarachnoid cisterns at the base of the brain, traverses the Sylvian fossa and spreads over the convexity of the hemispheres, gravitates downwards into the spinal theca where its presence may be revealed by lumbar puncture. It may burst into the substance of the hemisphere, and even penetrate into the lateral third and fourth ventricles. Occasionally an unruptured aneurysm of the internal carotid artery gives rise to pressure symptoms. These are third nerve palsy (ptosis, dilated and immobile pupil, external squint) pain in the distribution of the second division of the fifth nerve, sometimes blindness in the eye on the affected side, and proptosis. This picture may be followed by the appearance of signs of subarachnoid hæmorrhage.

From this brief summary of the various arterial lesions in vessels supplying the brain, we may draw the following conclusions: (1) that cerebral embolism is most common in young persons, particularly women, with endocarditis and mitral stenosis, or in persons with subacute infective endocarditis, (2) that cerebral hæmorrhage is a disease of elderly persons, particularly males, with atheroma, cardiac hypertrophy, high blood pressure, and granular kidney, (3) that cerebral thrombosis may occur in elderly persons of the type indicated under (2), and also in young adults, particularly males, who are syphilitic, (4) aneurysms at the base of the brain are of variable ætiology, and may be found in persons of all ages, and may give rise to symptoms at any age commonly by rupturing.

III SYMPTOMATOLOGY

A sudden onset with a 'stroke' or apoplexy is a feature common to all extensive vascular lesions of the brain, be they due to hæmorrhage, embolism, or thrombosis. When, as is commonest, the lesion involves the region supplied by the middle cerebral artery, the residual and permanent disturbance is hemiplegia. There is a close resemblance, therefore, between

the initial and the residual symptoms caused by these three vascular lesions. It is often difficult to differentiate hæmorrhage from thrombosis at the time of onset, though cerebral embolism is, for reasons which will be given, commonly recognisable as such, but the hemiplegia is in each case identical in character. The features of the apoplexy due to each lesion may be separately described and a discussion of their clinical differentiation will be given later.

(a) *Hæmorrhage*—In the case of intracerebral hæmorrhage the seat of rupture is usually in the region of the corpus striatum, anteriorly near the caudate nucleus laterally in the external capsule from the lenticulo striate artery, or posteriorly between the thalamus and the lenticular (lentiform) nucleus. In every case the blood invades the lenticular nucleus and internal capsule (Fig 16, p 747).

Rarely, premonitory symptoms are present, consisting of headache, vertigo, mental confusion and disturbance of speech, with unilateral paræsthesiæ and weakness. These are rapidly followed by the apoplectic seizure. In severe cases the patient is deeply unconscious, the face may be flushed or less commonly pale, the body is covered with perspiration and the pulse is slow and hard. Respiration is laboured and stertorous. Urine and feces may be voided, and the muscles are completely flaccid. The pupil and tendon reflexes are frequently absent. In these circumstances death may ensue within a few hours and is preceded by Cheyne Stokes breathing and an acceleration of the pulse. The temperature may fall one or two degrees and remain below normal until death, but when life is prolonged the initial depression gives place to a slight febrile reaction which lasts for some days. Vomiting sometimes occurs at the moment of onset, but convulsions are exceptional. Frequently, when coma is deep, blisters appear on the heels and other dependent parts.

If death does not ensue, consciousness begins slowly to return after some hours, and delirium and restlessness may appear. Death follows, in at least 30 per cent of cases of cerebral hæmorrhage, within the first two days. While the patient is yet unconscious, signs of a unilateral lesion may be discoverable, and on return of consciousness a residual hemiplegia is revealed.

This description applies to the common case of hæmorrhage from the middle cerebral artery. In the case of certain other vessels the symptomatology may vary in detail.

Pontine Hæmorrhage—Apoplexy is the rule, and is commonly ushered in by convulsions, which may involve the

legs more markedly than the arms. The signs of the nervous lesion are bilateral. The pupils are strongly contracted at the onset, but before death may dilate widely. Vomiting is common. A rapid rise of temperature develops, and before death, which is the rule, a temperature of 108°F may be reached.

Ventricular Hæmorrhage — While usually secondary to intracerebral or subarachnoid hæmorrhage, primary effusion of blood into the ventricles has been recorded. Rapid onset and deep coma are the rule. There may be head retraction, intense rigidity of all four limbs, and periodical accesses of intense tonic and clonic spasm. Death ensues rapidly.

Subarachnoid (Meningeal) Hæmorrhage — The usual source of hæmorrhage in this case is an aneurysm on the circle of Willis or upon one of the cerebral arteries in its neighbourhood.

The hæmorrhage may take the form of slight and recurrent leakages, or of massive and rapidly fatal bleeding. This may occur at any age and seems especially common in the third and fourth decades, that is, at an earlier age than is the case with hæmorrhage in the substance of the hemisphere.

When leakage occurs there is intense occipital headache, stiffness of the neck, vomiting, and vertigo, occasionally epileptiform seizures. Consciousness may or may not be lost, according to the severity of the bleeding. A massive albuminuria may be present for a day or two from the onset, and is apt to lead to an erroneous diagnosis of renal disease if its occasional occurrence with this lesion is not known. Signs of meningeal irritation ensue in non fatal cases, and persist with mild fever for two or more weeks. Complete recovery is common in cases of this kind.

When bleeding is rapid and massive, the onset with headache is rapidly followed by deepening coma and death.

Other physical signs that may be observed are large subhyaloid hæmorrhages in the fundus of the eye, œdema of the optic discs, pupillary anomalies, and squint. Hemiplegia is absent, but there may be bilateral extensor plantar responses.

This type of hæmorrhage is more common than is usually supposed and for this reason, and on account of the relatively early age of the subject frequently escapes recognition.

In all cases of hæmorrhage into the subarachnoid space, lumbar puncture reveals abundant blood in the cerebrospinal fluid. When the blood-stained fluid is allowed to stand the corpuscles settle, leaving a yellow supernatant serum. Lumbar puncture is, therefore a diagnostic procedure of importance in cases of suspected subarachnoid hæmorrhage. During

recovery high cell counts (lymphocytosis) may be obtained from the cerebrospinal fluid.

(b) *Embolism.*—The characteristic feature of embolic occlusion of an artery in the brain is the absolute suddenness of onset of symptoms. These vary in severity and type according to the size and the distribution of the vessel concerned. Emboli are most frequently arrested in the middle cerebral artery or one of its branches. When the main trunk is occluded, a large region of the affected hemisphere is rendered ischaemic, and the initial and residual symptoms resemble those due to haemorrhage from this artery. Convulsions may occur at the moment of onset, consciousness is instantly lost, and signs of hemiplegia are present. With occlusion of a small cortical branch, headache, vertigo, and unilateral paræsthesiæ and weakness replace coma. Focal signs necessarily vary according to the region of brain affected. Thus aphasia, monoplegia, or a Jacksonian convulsion may be produced. Rapid recovery of function sometimes follows the temporary occlusion of such small vessels, but in the case of the main trunk of the middle cerebral artery, permanent and severe hemiplegia is to be expected. The anterior cerebral artery is very rarely involved, but the posterior cerebral artery not infrequently, with the production of hemianopia and sensory change. Rarely the internal carotid is blocked in this manner with the production of the so-called *carotid hemiplegia*, in which severe and permanent hemiplegia is associated with blindness of the eye on the side of the occlusion from blocking of the ophthalmic artery. In basilar embolism, signs of a brain-stem lesion with hyperpyrexia develop.

(c) *Thrombosis.*—Far more varied than the clinical pictures of haemorrhage and embolism are those produced by atheromatous occlusion of the cerebral arteries. While the two former necessarily produce acute disturbances of cerebral function of absolutely sudden onset, it is not surprising from what we know of the diffuse and progressive nature of atheromatous degeneration of the arteries that it should give rise to both acute and chronic changes in the brain with corresponding acute and chronic symptoms. While the thrombotic occlusion of a large cerebral artery, the middle cerebral for example, will be followed by an apoplectic seizure, differing only in detail from that occurring in cerebral haemorrhage or embolism, the slow progress of atheroma in tiny cerebral arteries will be associated with a slowly progressive disturbance of cerebral functions, punctuated at intervals by more or less serious and transient "seizures" or "attacks" as some fresh

and circumscribed region of the brain is temporarily or permanently deprived of its blood supply. These "seizures" may involve any of the known functions of the cerebral hemispheres according to the distribution of the artery involved. Thus more or less transient hemianopia, sensory loss, hemiparesis aphasia, or mental confusion may occur in numerous sequences and combinations, each separated by periods of remission of symptoms and more or less complete return to normal. It is sometimes sought to explain the rapidity with which patients recover from these paralytic manifestations by invoking transient spasm, "angiospasm" of the cerebral arteries. Apart from the fact that the muscular element is less developed in the cerebral than in the other arteries of the body, and that the former are therefore the less likely to be transiently occluded by muscular spasm it has to be remembered that in the circumstances now under consideration the arteries are profoundly degenerated and are probably wholly incapable of fluctuating variations in calibre for this reason. A far more reasonable view is that fluctuations in blood pressure allow the flow through narrowed arteries transiently to cease or to diminish so that the nervous tissues cease to function until the blood supply is adequately restored. If such restoration occurs before irreparable damage has ensued then function resumes and paralytic manifestations clear up. In hypertensive encephalopathy (*vide p. 786*) transient focal signs such as hemiplegia, may occur, and perhaps in this condition arterial spasm may play a part.

Generally however this kaleidoscopic symptomatology of diffuse cerebral arterial degeneration is accompanied by a slowly progressive deterioration of the highest cerebral functions and by an insidiously developing physical disability. Finally, a fatal hæmorrhage or thrombosis may terminate the patient's existence for it must be remembered that in atheroma we have a lesion which may result either in hæmorrhage or in occlusion and it is not uncommon for the subject of one or more thrombotic seizures to be finally carried off by hæmorrhage. In the case of the middle cerebral artery, again the artery most frequently affected the apoplexy and resulting hemiplegia do not differ essentially from those already described in association with hæmorrhage. Certain differences in the mode of onset are, however, characteristic of thrombosis. There may be premonitory symptoms, both general and focal and when occlusion is finally established profound hemiplegia may develop over a period of one or more hours with little or no disturbance of consciousness. Not infrequently the subject

retires to bed apparently in his usual health, to awake next morning fully conscious but with hemiplegia. In short, the disturbance of consciousness in thrombosis is apt to be less sudden in onset and less severe in degree than in a hæmorrhage causing a residual hemiplegia equally profound. Not uncommonly the onset is marked by a convulsion. In those cases where occlusion spreads proximally in a vessel from its distal end, gradually deepening coma and progressively increasing paralysis may occur. But in some instances a patient may pass from deep coma into a state of profound stupor with delirium, in which he may remain for several weeks until death ensues. On the whole, survival is more common in thrombosis than after hæmorrhage, and the fact of survival in a doubtful case is evidence in favour of thrombosis.

The residual focal symptoms which may follow occlusion and subsequent softening vary widely, according to the particular artery occluded. In the case of cortical branches, any of the known functions of the hemispheres may be affected. Occlusion of these branches of the anterior and posterior cerebral arteries is relatively uncommon except in the chronic cases above mentioned. In the case of the basilar artery the symptoms vary in detail according to the level of the occlusion and the extent of involvement of the lateral branches. The essential features, however, are cranial nerve palsies with crossed hemiplegia or crossed sensory disturbances, the so called "alternating paralyses." The posterior inferior cerebellar artery is occasionally blocked and a characteristic syndrome results. Blocking of the cerebellar branches of the artery produces sudden acute ataxia on the side of the lesion, intense vertigo with forced movements, nystagmus, and vomiting, while the cutting off of the blood stream in the perforating branches which pass into the lateral region of the medulla produces (i) a crossed hemianæsthesia for pain and temperature, (ii) uncrossed symptoms referable to the fifth nerve (anæsthesia of the same side of the face), sixth nerve palsy (paresis of the external [lateral] rectus and diplopia), the glosso pharyngeal vagus accessorius complex (unilateral paresis of the palate, hoarseness of the voice), and paralysis of the sympathetic (enophthalmos, defective dilatation of the pupil in shade).

Slowly progressive disabilities related to arterial thrombosis have already been referred to, the essential lesions being multiple, recurrent, circumscribed areas of softening. Variable as the clinical expressions of this state of affairs may be,

there are a few characteristic syndromes which may be briefly referred to

Pseudo bulbar Paralysis—There is generally a history of two or more "strokes" which may have been comparatively mild, and without loss of consciousness or profound hemiplegia. The symptoms are caused by bilateral lesions in the region of the internal capsule, though in practically all cases of the kind cortical thromboses in the distribution of the middle cerebral artery are also present. They are those of bilateral hemiparesis with the addition of marked emotional overaction of the facial musculature, forced and uncontrollable weeping and laughter and a gross disturbance of articulation. Considerable mental deterioration is also present in most instances.

Chronic Softening—This may be taken to include the recurrence of thrombotic lesions, involving any of the cortical areas and producing the variable series of transient visual, sensory, speech, motor, and mental disturbances already described together with progressive mental deterioration.

Finally, a condition known as "*arteriosclerotic muscular rigidity*" has been described in which the patient develops a diffuse muscular rigidity, resembling that of paralysis agitans, with a characteristic gait in which he takes very short and shuffling steps. There may be no unequivocal signs of pyramidal tract involvement.

The Cerebrospinal Fluid—Intracerebral hemorrhage and thrombosis may produce no other change in the fluid than a rise of pressure, though in the subjects of cerebral arterial disease and chronic interstitial nephritis an excess of protein may occur quite apart from the cerebral lesion. When after hemorrhage blood reaches the ventricles, the cerebrospinal fluid may contain blood corpuscles, and when these are allowed to sediment the fluid may be yellow tinged. A similar state of affairs may also follow extensive thrombosis, but on the whole such a finding suggests hemorrhage as the condition present. In subarachnoid hemorrhage, as is mentioned elsewhere, the fluid may be bright red from the onset becoming clearer within a few days and yellowish in colour as the corpuscles disintegrate.

IV HEMIPLEGIA

The significance of the dual symptomatology of both recent and residual hemiplegia has already been discussed in the introductory chapter to this section, and further clinical details may now be added.

In coma, the signs of hemiplegia serve to differentiate apoplexy from the coma of various toxic states, endogenous or exogenous. The check on the affected side blows in and out loosely with each respiration. The limbs on that side also may be more flaccid than those of the opposite limb. Sometimes this is visible as the patient lies on his back, because the affected thigh loses its contours and flattens out. The head and eyes may show "conjugate deviation" towards the paralysed side, that is, away from the side of the lesion. This is an irritative phenomenon and transient in duration. Of even greater value than any of these signs is the presence on the hemiplegic side of an extensor or Babinski plantar response, and of unilateral absence of the abdominal reflexes on the same side.

After consciousness is regained, the phenomena of hemiplegia are fully revealed, and consist in a loss or impairment of unilateral voluntary movements. The face is paralysed in its lower half, the upper half being relatively little affected. The tongue is protruded towards the paralysed side, owing to the unantagonised action of the genio hyoglossus (genio-glossus) of the normal side.

The initial conjugate deviation of head and eyes towards the paralysed side gives place to a transient weakness, of some days' duration, of movement of both head and eyes towards the paralysed side. The movements of mastication and ordinary respiration are intact. At first, the arm and leg may be totally paralysed. The limbs are flaccid, but the tendon jerks by this time are brisker on the paralysed than on the normal side. The abdominal reflexes are lost on the paralysed side and the plantar response remains of the extensor type.

In partial hemiplegia the face is relatively slightly affected and the tongue may escape, while in the case of the limbs the arm is more severely affected than the leg.

Chronic Residual Hemiplegia—After the passage of two or three weeks the hemiplegia undergoes certain changes, consisting in a degree of return of voluntary power and in the development of spasticity or hypertonus in the limb muscles. Recovery may be arrested at any stage, and a severe degree of residual paralysis persist. The condition in the limbs is one of loss, partial or complete, of movements, and not simple paralysis of individual muscles. The movements which return earliest and most completely in the arm are those of elevation and abduction of the shoulder, of flexion at the elbow, and of flexion of the fingers and wrist. Extension at the elbow frequently remains feeble and restricted, while extension of

wrist and digits and still more isolated movements of the digits commonly remain absent. Thus an individual with a grasp of fair power may have no other useful movement of the hand or fingers whatever. In the leg extension at hip and knee and plantar flexion of foot and toes return earliest and most completely and may be of sufficient power to enable the patient to stand at a time when flexion at hip and knee are feeble and restricted and there is no trace of dorsiflexion of foot or toes. Indeed these last two movements frequently remain absent permanently.

The spasticity like the return of voluntary movement is selective in incidence appearing in the adductors and flexors of the upper arm and in the extensors and plantar flexors of the lower, that is in the muscles which become the strongest in the limbs. The spasticity however handicaps the activity of these predominant movements and renders them slow and clumsy.

It follows that the hemiplegic subject takes up a characteristic posture when standing with the arm flexed and adducted and the leg extended and the foot plantar flexed.

Another feature in this phase is the appearance of the so-called associated reactions. Any forcible voluntary contraction of the muscles on the normal side or such semi-voluntary movements as yawning or stretching give rise to sudden accesses of tonic spasm in the paralysed arm and leg and thus spasm leads to the taking up of a fresh attitude of the limb while the movement evoking it lasts. Thus in yawning the arm usually rises up before the patient's face and the wrist and fingers extend. These activities are wholly involuntary and cannot be reproduced at will by the patient. The tendon reflexes in the affected limbs become extremely brisk and the phenomena of knee and ankle clonus may appear. In some cases the abdominal reflexes on the hemiplegic side ultimately return but the plantar response remains permanently of the extensor or Babinski type.

Finally in long standing cases some degree of secondary fibrous change takes place in the inactive muscles and the posture may become fixed but the leg never goes into flexion contracture in an uncomplicated case of hemiplegia without spinal cord lesions.

V DIAGNOSIS

The association of coma with acute cerebral vascular lesions renders diagnosis a matter of difficulty when the subject is found unconscious and nothing is known of the rapidity or

modo of onset Sudden onset, that is, apoplexy, is practically always indicative of a cerebral vascular lesion

The various causes of coma may be briefly discussed under the headings of (a) toxæmic, (b) post epileptic, (c) traumatic, and (d) cerebral lesions other than trauma

(a) Toxæmic —In all cases of this nature the coma is rarely as profound as after a cerebral hæmorrhage and signs of *unilateral* cerebral lesions are wanting In uræmia the subject may be of such an age and general condition as to make cerebral vascular disease probable Hence the presence of albumen, blood, and casts in the urine does not necessarily exclude vascular disease as a responsible cause In uræmia, however, coma is not so profound some response to stimulation can usually be obtained the tendon reflexes are obtainable, muscular flaccidity and incontinence of urine or fæces are not present, and the plantar responses are usually flexor However, within a brief period of a uræmic convulsion the tendon reflexes may be lost and the plantar responses may be of Babinski type, but these signs are bilateral and very transient

In *diabetes* the examination of the urine makes diagnosis easy The reflexes are normal, unless a pre existing diabetic neuritis has led to loss of knee and ankle jerks

In *opium poisoning* the skin is cold and damp Respiration and the pulse are slow and feeble The reflexes are commonly stated to be normal, but in this, as in other forms of narcotic poisoning, the tendon reflexes may be lost and the plantar responses of Babinski type These signs when present are bilateral In opium poisoning the pin point contraction of the pupils is of diagnostic significance In cholæmia and delayed chloroform poisoning the plantar responses are commonly of the extensor type, and in rare cases signs of a unilateral cerebral disturbance may be present Hence in the absence of a history of previous symptoms and of mode of onset diagnosis may be difficult

(b) Post-epileptic Coma —For the period of a few minutes after all generalised epileptiform convulsions, the pupils are inactive to light, the corneal reflexes absent, the tendon reflexes abolished, and the plantar responses of Babinski type These phenomena are transient, there are no signs of unilateral cerebral lesion, and certain features indicative of convulsion may be present, *e.g.*, tongue biting incontinence, the presence of old scars of injuries sustained in previous fits

(c) Traumatic Cerebral Lesions —In cerebral concussion the patient loses consciousness instantly at the moment of injury

The condition is one of collapse—low blood pressure, weak pulse, slow and shallow respiration, pale face, dilated pupils, and flaccid muscles. As coma passes off signs of irritability and restlessness appear. The pulse is forceful, respiration becomes deeper, and the temperature may rise two or more degrees. Finally, consciousness is regained with the appearance of headache.

In extra-dural meningeal hæmorrhage the concussed patient regains consciousness, and then, with the rise of blood pressure, hæmorrhage begins, and the symptoms of compression of the brain develop within the course of a few hours. The patient passes through a phase of cerebral irritation back into coma. As pressure rises within the skull, unilateral symptoms, first irritative and then paralytic, make their appearance. Jacksonian fits, followed by hemiparesis with corresponding reflex changes. Other focal signs appear according to the region in which compression is most severe.

The development and clinical picture of chronic subdural hæmatoma has been dealt with in the chapter on the meninges.

(d) *Non-traumatic Cerebral Lesions*—The age and general condition of the subject may afford valuable information as to the nature of the lesion. Thus endocarditis and mitral stenosis are associated with embolism and occur in young subjects particularly in women.

A mode of onset suggestive of cerebral thrombosis when present in a young adult, particularly a male, indicates syphilitic endarteritis.

In elderly persons with high blood pressure, cardiac hypertrophy and signs of interstitial nephritis, either hæmorrhage or thrombosis may be in question. A differentiation may be impossible but the mode of onset often enables a correct diagnosis to be made.

As to mode of onset, embolism is characterised by absolute suddenness without prodromal symptoms. In hæmorrhage transient premonitory symptoms of the type already described may be present. Coma is deep, and the general appearance of the patient has been discussed above. In thrombosis, due either to syphilitic endarteritis or to atheroma, onset is less sudden. The hemiplegia may begin to appear before consciousness is lost, and epileptiform convulsions may usher in the development of the lesion. Coma may be absent, or may be transient and not deep. Recovery of consciousness and survival is presumptive evidence in favour of thrombosis as opposed to hæmorrhage. Again, an onset during sleep after

a day of fatigue is more common in thrombosis than in hæmorrhage, which is sometimes associated with physical effort. A sudden onset of coma with death within a few moments is practically never due to a cerebral lesion but to coronary thrombosis and cessation of the heart beat.

The appearance of intense headache, followed rapidly by coma and death, is commonly due to subarachnoid hæmorrhage from rupture of a basal aneurysm and may occur in otherwise healthy subjects of any age.

Apart from primary cerebral vascular disease, hæmorrhage into the brain may occur in a variety of conditions. Thus hæmorrhage into a growing glioma may be rapidly fatal or it may be a terminal incident in acute leukaemia and other altered blood states. In certain acute infections such as diphtheria, and in septic conditions such as puerperal sepsis embolism and thrombosis may occur.

VI PROGNOSIS

In intracerebral hæmorrhage death occurs in a large proportion of cases within forty-eight hours. Survival is more likely after thrombosis but here ultimate prognosis as to life is influenced by the persistence of the factors which gave rise to the original cerebral lesion. In arterial disease the subject remains a precarious life always liable to recurrent "strokes." In some cases of atheroma with thrombosis, when the patient's mode of life is carefully regulated, a useful if restricted existence may be enjoyed for several years without recurrence of cerebral lesion. In syphilitic thrombosis on the other hand, prognosis is determined by the thoroughness with which antisyphilitic measures are initiated and carried out. In the matter of recovery from hemiplegia, prognosis is gravest after hæmorrhage, since actual destruction of tissue has occurred. In transient occlusion, from thrombosis or embolism complete or almost complete recovery of function sometimes occurs, but it is usually found that the fine purposive movements of an affected hand are not completely regained in any but the most fugitive hemiplegias.

In subarachnoid hæmorrhage free and continued hæmorrhage may prove rapidly fatal. In many cases the bleeding is less copious and of brief duration. In these circumstances recovery is common. The liability to recurrent bleeding is greatest in the fortnight following the original subarachnoid hæmorrhage. In many patients recovery is followed by complete restoration to normal health and later recurrence does not

occur, but it is impossible to estimate the expectation of life in the individual case

VII TREATMENT

The recognition of arterial disease in an elderly person at a time when no manifestation of involvement of the cerebral vessels is present calls for some circumspection in the matter of treatment. Many persons in whom routine examination has revealed the presence of a high blood pressure are made utterly miserable in their remaining years by severe restrictive measures of uncertain value, accompanied by unwise and dismal forebodings on the part of their medical advisers. If the patient cannot be induced to lead a regular life and to exercise moderation in all activities without being put in perpetual dread of apoplexy, his medical adviser will probably prefer to leave him some measure of peace of mind, even at the risk that something less than an ideal regime of life may be continued. Once however definite indications of cerebral vascular disease have appeared such as headache, vertigo, paræsthesiæ, or other transient focal disturbances of function or after a definite structural lesion, the patient must face a restricted life. Fatigue, excess of food or alcohol are all strongly contraindicated.

Whether systematic attempts to lower the level of blood pressure are effective or if effective of value is doubtful. But factors likely to cause wide fluctuations of blood pressure the common immediate cause of both hæmorrhage and thrombosis, are to be avoided.

In both hæmorrhage and thrombosis the patient must be kept at rest. In unequivocal cases of hæmorrhage when there is a strongly acting heart, a flushed face and an incompressible pulse, early venesection may be of value from 10 to 15 oz. of blood being removed. But a soft, irregular pulse and the presence of any doubt as to whether the case is one of hæmorrhage or thrombosis strongly contraindicate venesection.

Again, in cases of hæmorrhage early and free purgation has been thought to be of value because of the dilatation of the abdominal vessels which it produces, and croton oil is used for the purpose.

In thrombosis, the use of cardiac stimulants is indicated, and the administration of easily assimilable foods may be attempted.

The treatment of subarachnoid hæmorrhage depends largely upon the severity of the case. When consciousness is not lost,

or only briefly, we may assume that no considerable increase of intracranial pressure is present, and therefore the diagnostic lumbar puncture having been made, there is no indication to repeat the procedure. In these circumstances, the prime necessity is to keep the patient as quiet as possible and to relieve the headache and pain in the neck and back associated with meningeal irritation. For this purpose morphia may be necessary for several days, though milder sedatives may serve in some cases. When there is deep or prolonged coma, repeated drainage of the subarachnoid space by lumbar puncture may be indicated. The depth of coma and the pulse rate must be studied to determine the frequency which is best in any given case. During recovery, restlessness and mental confusion may persist for three or more weeks and may require the use of luminal or other comparable sedatives.

In all cases, the possibility of retention of urine should be borne in mind.

Pulmonary congestion and broncho pneumonia carry off many patients who survive the immediate shock of the cerebral lesion. This complication may be figuratively spoken of as a "bedsore in the lung" and like the bedsores which may develop elsewhere, is to be prevented by careful changes in the position of the patient in bed.

Once the period of coma is passed and the presence of severe hemiplegia is revealed, the careful prevention of contractures and deformities must be taken in hand without delay. The leg must be kept extended, adducted, and rotated in, and the foot supported. The hand and digits must not be allowed to lie in a constant posture of flexion, which will invariably be the case unless active measures are taken to prevent it. Careful and gentle passive movements of the limbs may be begun as soon as convalescence from the cerebral lesion is established, but it is probable that premature active use of partially paralysed limbs may promote the development of spasticity. After the fourth or fifth week, however, if power is returning into the limbs, some active exercise is essential. Electrical stimulation at any stage, early or late, is strongly contraindicated. In transient hemiplegia where complete recovery is in sight it is not necessary, while in permanent residual cases it aggravates spasticity.

For the hand in old spastic hemiplegia, active use of the fingers is the best form of local treatment, and exercises to meet the conditions present are readily devised. In such cases the degree of ultimate recovery depends more upon the assiduity with which the patient carries out such exercises than upon

any other factor, and massage is not an adequate substitute for them. When the fingers have regained some movement the handling of dominoes and other small objects is a useful form of re-education. It is clear, however, that all measures of the kind are of value only in subjects in otherwise good general health and with normal mental faculties.

DISTURBANCES OF SPEECH

Articulate speech and writing (and, to a less degree, gesture) are highly specialised forms of movement by which the individual expresses his thoughts. Spoken and written words are the symbols employed for this purpose and like other movements those of speech and writing are ultimately under the directive influence of sensory impressions. Some simple general ideas of the speech function and its disorders in disease may be gained by pursuing the analogy with movement still farther.

Co-ordinated movement may be disordered by a cutting off of the sensory impressions which normally reach the cerebral sensory cortex, or by a failure to integrate these sensations when they arrive. In these circumstances the disorder of movement resulting is not in the nature of weakness or loss of movement, but is an inco-ordination; movements can still be made but they are wrong movements. If the subject's eyes be closed, he is not aware of the disorder, and can make no attempt to correct it.

When the efferent or executive side of the mechanism of co-ordinated movement is damaged, movements are weakened or lost. This loss will depend for its character upon the particular level of the motor mechanism which is out of order. The lesion may involve either the lower or the upper motor neurone with results appropriate to the seat of the lesion in each case. However, the lesion may involve even higher levels of the mechanism, the so-called supraventricular centres. When this happens there is no paralysis in the ordinary sense of the term, but the subject is unable to initiate certain purposive movements at will.

Further, in the case of any given function it is always its most complex expression which is earliest and most severely damaged, as was mentioned in the introductory chapter to this section.

In speech we are dealing with a higher grade of cerebral activity than the mere performance of co-ordinated movements,

because the auditory and visual impressions received when the subject hears spoken, or sees written words, have acquired a symbolic meaning, they have become the coinage of thought. Similarly the movements of spoken and written speech, and to a less extent those of gesture, have also acquired a symbolic value under the influence of these highly elaborated visual and auditory impressions. This investing of sensory impressions and of movements with symbolic significance is the result of intellectual processes and therefore there are anatomical, physiological and psychological aspects of the speech function. Anatomical in that the neurones concerned in the receptive and expressive functions described above are grouped in certain more or less well defined cortical areas. Physiological in respect of the specific activities of these neurones and psychological in respect of the mental processes which are manifested in speech. Thought is possible without words but for the expression and exchange of thought they are clearly essential.

The groups of neurones concerned in the endowment of visual and auditory impressions with symbolic value and those which initiate the movements of written and spoken speech are all localised in the left cerebral hemisphere, in what for purposes of exposition are spoken of as centres. The so-called auditory word centre is situated in the first temporal convolution, the visual word centre in the angular and supramarginal (inferior parietal) convolutions, and the motor speech centres at the posterior ends of the second frontal convolution (writing) and third frontal convolution (speech). The latter is often known as Broca's area.

These cortical areas are intimately connected by association fibres in the subcortex and together are included in a roughly quadrilateral region on the convexity of the hemisphere. As is to be expected, lesions involving the anterior portion of this region tend to impair executive speech functions predominantly, those involving the posterior part the receptive aspects of speech (see Fig. 18, p. 768).

In left handed persons the speech centres may lie in the right hemisphere, and lesions in this hemisphere may be followed by disorders of speech of the kind under consideration, while lesions of the left hemisphere produce no such disorders. Occasionally, also, a right handed member of a stock in which left handedness is known to be common, may show speech disorders after a lesion of the right hemisphere. Such an individual is said to have come from a 'right brained stock'. The converse condition is also known to occur.

Morbid Anatomy and Pathogenesis—Lesions of any nature involving these cortical regions will produce disturbances of speech function of a degree and kind proportionate to their severity and topography. The commonest cause of such lesions is atheroma of the cortical branches of the left middle cerebral artery, with resulting arterial occlusion and thrombosis. Speech defects are therefore a frequent symptom in vascular lesions within the territory of this artery. Tumour and abscess within the same region will produce comparable defects.

SYMPTOMATOLOGY—**Expressive, or Motor Aphasia**—In this we have a greater or less degree of loss of the power of expressing thought in speech. The speech musculature is not paralysed and can still carry out all movements other than those of articulate speech, but the latter are lost or greatly reduced in number. The loss may vary from a loss of names (nominal aphasia) to a loss of all but a few recurrent utterances such as "Yes," "No" or "Thank you." Such words as are uttered are perfectly articulated, except in very fresh lesions, when some dysarthria may be present. In nominal aphasia the patient can recognise an object held before him but cannot name it. Instead, he describes it, speaking of a pencil as "what you write with." In conversation he has to adopt similar periphrases. Simple questions on long familiar topics may be answered correctly, but more complex ones involving the use of words in thinking (internal speech) may find the patient unable to express himself. It is sometimes noticed that a patient who is reduced to a few recurring utterances can, under the influence of emotion speak volubly or even sing the words of a song, the expression of emotion being less severely impaired than that of thought.

Lesions having this effect commonly involve Broca's convolution which lies at the posterior end of the third left frontal convolution and at the foot of the ascending frontal (precentral) convolution.

When the posterior end of the second frontal convolution is involved, the movements of writing are impaired or lost, a condition known as *agraphia*. Here, as in the case of the articulatory muscles, all other movements of the hand and fingers may be intact.

These two disturbances of expressive speech may be present simultaneously, or either may be found alone.

Clinically, it is commonly, though not invariably, found that persons with motor aphasia cannot understand what they read, they are "word blind," and this even in the absence

of any lesion of the visual word centre. This symptom is supposed to be due to an inability of many persons to read with understanding unless they can "say over" silently what they read. The motor aphasic cannot do this, and hence is unable to pick up the meaning of the words he sees.

Sensory, or Receptive Aphasia—Here we have a defect of comprehension of spoken or of written speech (word deafness, or word blindness) in the absence of deafness or blindness. The executive mechanism of speech in uncomplicated cases remains intact. Since auditory and visual impressions have lost their appropriate symbolic value for the patient, not only does he not understand what he hears or reads, but the activation of the executive mechanism is disordered and he uses wrong words, mixes up the words in a sentence and may talk an unintelligible jargon. To return to the analogy of movement, we may say that the patient can make speech movements, but they are wrong movements.

Almost pure word deafness or word blindness may exist alone, but the two are more commonly present together. Similarly, in the majority of instances lesions are so placed as to involve both the receptive and the expressive parts of the speech mechanism, so that so called mixed forms of aphasia are found. Lesions involving any of the so called speech centres tend to interrupt association paths between the different parts of the cortical representation of speech, and so produce these complex disturbances.

The patient's comprehension of spoken and written speech may be tested by giving him oral and written orders of a simple character and noting his response. His powers of expression are tested by asking spoken or written questions which demand verbal or written responses, by asking him to name and identify objects shown to him or to use them appropriately.

APRAXIA AND AGNOSIA—In certain cortical lesions immediately anterior to the cerebral motor cortex, not only may motor aphasia or agraphia result but there may also be an inability to perform other purposive movements to order, and this although the muscles concerned are not paralysed for other movements, or for the same movements when carried out spontaneously. For defects of this type, in which motor aphasia is included the term *apraxia* has been coined. The subject of motor apraxia cannot carry out certain complex movements to order and cannot handle familiar objects, such

as a pipe a cigarette, or a key, appropriately, although he is aware of their nature and proper use

On the afferent side also not only may the significance of words heard be lost, but objects perfectly seen may not be identified by the subject, or are wrongly identified. This defect is spoken of as *agnosia*, and word deafness and word blindness are special varieties of *agnosia*.

All these elaborations of received sensory impressions and the corresponding performance of purposive movements are functions of cortical cells and hence the various expressions of *apraxia* and *agnosia* are seen in the subjects of cortical lesions.

DYSARTHRIA—In addition to the disorders of speech already considered it is clear that paralysis or inco-ordination of the speech musculature will render articulation difficult or impossible.

Such defects may be classified under the same headings as other disorders of movement. Thus in spastic conditions of the musculature, *e g.*, in pseudobulbar paralysis and in spastic forms of chronic bulbar palsy the patient may be reduced to making wholly inarticulate sounds (*anarthria*), in general paralysis articulation is slurred, in cerebellar disturbances such as follow lesions of the cerebellum and are seen in disseminated sclerosis and Friedreich's ataxy, the articulation is of the scanning type. Finally, in lower motor neurone paralysis and in muscular diseases (*myasthenia gravis*, *myopathy*) defects of voice production as well as of articulation may occur. The features of these various forms of articulatory defect are considered under the heading of the diseases in which they occur and need not be further described. Their treatment is that of the causative condition.

STAMMERING—This impediment of speech is of quite another order from the defects of speech so far considered. It is frequently inherited and associated with a neuropathic diathesis. It appears in early childhood, and is by nature allied to the tics and the psychoneuroses. It is, therefore, not due to any local disease of the neuromuscular mechanism of speech but to a disorder of voluntary co-ordination between the respiratory, the laryngeal, and the labio lingual components of this mechanism. The general principles of treatment enunciated for the tics and psychoneuroses apply to the treatment of stammering with the addition under trained supervision of breathing singing, and reading exercises.

THE CEREBRAL PALSIES OF CHILDHOOD

CEREBRAL DIPLEGIA

Under this heading are grouped a number of clinical conditions characterised by signs of bilateral affection of the cerebral hemispheres dating from birth

Ætiology.—It is thought by some that agenesis or defective development of different systems of neurones, the latter occurring at varying periods of development may be responsible for all the conditions included under this heading. It is probable, however, that disease processes during intra-uterine life also play a part in their production

The widely held view that cerebral injuries sustained during parturition play a part in the production of cerebral diplegia rests upon no sound clinical or pathological grounds. The child is frequently the first born of its mother, and when abnormalities of labour and delivery are present these are as frequently of the nature of precipitate birth as of prolonged or difficult labour. Further, there is no pathological evidence that birth injuries stand in any relation to cerebral diplegia. On the contrary, there is every reason to conclude that ante-natal factors are alone operative

Morbid Anatomy.—Amongst the various pathological conditions found in the brains of subjects of cerebral palsies of congenital origin is *atrophic sclerosis*. The convolutions are shrunken, with wide intervening sulci. The whole or part only of the cerebral hemisphere may be affected. Microscopically, there is found a marked glial proliferation and defective myelination of the nerve fibres

Symptomatology.—The following clinical types have been described —

1 *The Spastic Group* — There is generalised muscular rigidity, usually predominating in and sometimes confined to the lower limbs. These are rigidly extended and adducted, and may be crossed. When rigidity allows of their elicitation, the knee and ankle jerks are found to be increased and the plantar responses of the extensor type. The abdominal reflexes are generally retained. This condition is found in degrees of severity varying from slight rigidity and disorder of gait to intense adductor spasm and rigidity with "scissors gait" and an inability to place the heels on the ground. The arms may be intact and the patient's mental development normal. This is the clinical picture of what is known as

Little's disease In other cases the arms also are involved and there is a varying degree of mental deficiency and, sometimes, epilepsy

2 Bilateral Athetosis—The limb and facial musculature is the seat of more or less continuous writhing movements ("mobile spasm") which are aggravated and spread during all attempts at voluntary movement The muscles of articulation and mastication may be involved These phenomena are minimal at birth and tend to increase in severity later in childhood There is a varying degree of associated mental defect

3 Choreiform Group—This is characterised by the presence of jerky, rapid involuntary movements of choreiform type, involving the limb and articulatory musculature There may be no signs of pyramidal involvement, and in some instances no mental defect

Treatment—The only cases for which anything can be achieved by treatment are those in which the legs are spastic, but the arms normal and the child's mental development good In these, it is sometimes possible by judicious tenotomy and carefully planned motor nerve division to overcome muscular spasm and contracture When this has been done, the child may be educated to walk in a more normal fashion than was before possible

Further, some cases of the kind do undergo a measure of spontaneous improvement as they approach adolescence

INFANTILE HEMIPLEGIA

Rarely this is congenital in origin and due to the causes we have considered in connection with cerebral diplegia When cerebral injuries (compression or hæmorrhage) are sustained at birth, the resulting disability is a hemiplegia, and some cases of infantile hemiplegia arise in this way The common variety, however, makes its appearance suddenly during the early years of infancy in association with one or other of the acute specific infections In these circumstances its origin may be embolic, or due to hæmorrhage or thrombosis, or, finally, to a localised focus of encephalitis The infections in question are measles, mumps, scarlet fever, whooping cough, typhoid fever, and poliomyelitis

Symptomatology.—There is a sudden onset with generalised convulsions and coma which may persist for as long as twenty four hours In some instances the convulsions are unilateral A general febrile reaction accompanies these

symptoms On recovery the child is found to have a hemiplegia of varying severity. Sometimes aphasia results. Subsequently there may be partial or complete recovery, or a varying degree of residual hemiplegia and speech defect. Involuntary movements of athetotic variety are liable to appear in the affected musculature. Other common sequelae are mental deficiency and epilepsy.

Treatment—This consists in the treatment of the residual hemiplegia, which is conducted on the lines described in the case of adult hemiplegia.

(CEREBRAL THROMBO-PHLEBITIS)

Occasionally, phlebitis of the pelvic veins with thrombosis, such as may occur after pelvic operations or parturition leads to embolism, and since the pelvic veins are in connection—through the vertebral veins—with the cerebral veins and sinuses emboli may lodge in the latter. When this happens monoplegia or hemiplegia may develop suddenly. The sudden hemiplegia of the puerperium is probably caused in this way. Its prognosis as to recovery varies with the severity of the original paralysis and the treatment should be on the general lines for hemiplegia of other modes of vascular origin.

SINUS THROMBOSIS

Primary thrombosis of an intracranial venous sinus is a rare complication of marasmus in infants and of the acute specific fevers of childhood in their graver forms. In later life it may be associated with the cachexia of old age and malignant disease. In these circumstances it is the superior longitudinal sinus which is usually affected, and the issue is fatal.

Secondary sinus thrombosis is infective in origin. It may arise as part of a general pyæmia or, in the case of local suppuration in the skull the sinus may be infected by organisms reaching it by a tributary vein which drains the infective focus or by the direct extension of thrombosis from such a vein.

The lateral (transverse) sinus is the one most frequently infected in this way in association with chronic otorrhœa infection or thrombosis reaching it by the mastoid emissary veins. Once established in this sinus the process may spread to the petrosal and cavernous sinuses on the same side and extend into the internal jugular vein which can be felt in the

neck as a hard and tender cord. Pyæmic complications may follow, and metastatic abscesses and serous effusions have to be looked for.

The cavernous sinus may be infected in septic lesions of the face, while wounds of the vertex of the skull may produce longitudinal (sagittal) sinus thrombosis, either directly and apart from infection or as a result of this.

Symptomatology.—This includes the signs of the original septic focus and the constitutional disturbance resulting from septicæmia—fever, rigors, sweating, and loss of weight. There are also general and focal signs of intracranial disturbance. The general signs include headache, vomiting, papilloedema, and if meningitis supervene, the signs of this condition. The focal signs vary with the sinus infected.

The Lateral (Transverse) Sinus, when thrombosed, is often said to present no neurological symptoms apart from such complications as intracranial abscess and meningitis. It is therefore important to remember that in uncomplicated lateral sinus thrombosis there may be papilloedema, which in these circumstances is not necessarily a sign of ill omen and may clear up when the sinus has been opened and drained and the jugular vein ligatured.

The Cavernous Sinus—There is proptosis of the eye and localised œdema and congestion of the face. There may be ocular paralyses and blindness from infarction of the retina. If the latter occur, ophthalmoscopic examination will reveal retinal hæmorrhages and the appearances of thrombosis.

The Superior Longitudinal (Sagittal) Sinus drains the cortical veins from the motor cortex, and hence thrombosis results in bilateral hemiparesis in which the legs are predominantly affected and become extremely spastic in adduction. There may also be disturbances of vesical sphincter control and convulsions.

The Treatment of septic sinus thrombosis is exclusively surgical.

PARALYSIS AGITANS (PARKINSON'S DISEASE)

Definition—A slowly developing malady of elderly persons characterised by diffuse muscular rigidity, tremor, slowness and limitation of the range of movement, and by a peculiar stance and gait. In his original account (London, 1817), Parkinson described it as consisting of "involuntary tremulous motion, with lessened muscular power, in parts not in action and even when supported, with a propensity to bend the trunk forward"

and to pass from a walking to a running pace the senses and intellects being uninjured

Ætiology—Nothing certain is known of the causation of this malsdy. It is rare before the fifth decads of life, and from this period onwards the case incidence steadily increases. Males are mors frequently affected than females. Thus age and sex incidence are also those of cerebral arterial degeneration. In this connection it is noteworthy that a raised blood pressure is unusual in paralysis agitans while gross cerebral lesions of vascular origin (hæmorrhage or thrombosis) very rarely occur in the subjects of this disease. As is the case with all other chronic maladies of the nervous system of obscure ætiology, cold stress of all forms, trauma and infection have been invoked as causative or predisposing factors. There is however no conclusive evidence that any of them stand in any other than a relationship of coincidences with the apparent onset of the malsdy. The view that trauma may determine the onset and site of initial symptoms has been handed on from writer to writer but its reiteration is its most substantial claim to acceptance.

Morbid Anatomy—The essential lesions are found in the neighbourhood of the corpus striatum and subthalamic region and they consist in degeneration and necrosis of nerve cells and fibres. There may be actual lacune round the vessels. The process is essentially a senile one.

Symptomatology—The onset is insidious and muscular rigidity is commonly the earliest manifestation. The normal play of expression vanishes from the face which assumes a fixed mask-like appearance. The natural swing of the trunk and arms in walking diminishes; the gait assumes a gliding monotonous character and the arm on the earlier affected side ceases to swing and lies adducted and slightly flexed at the side of the trunk. The patient tends to assume an attitude of slight flexion, the head and back bent forwards and the legs not fully extended either in standing or walking. At first the affection of the limbs is unilateral but usually within two years the limb musculature of both sides is involved. All movements become slow and restricted in range. The patient experiences difficulty in rising from a chair in shaving and in dressing. Usually within a few months of onset the arm first affected becomes the seat of a fine rhythmic tremor, which may be present when the limb is at rest and fully supported or appear only when it is in action. Even then in rapid movements especially to and fro movements it tends momentarily to cease. It is increased by fatigue or emotion. The

leg is next affected and the head or the lower jaw may be tremulous. Sometimes tremor appears first in the index finger which then makes a 'pull rolling' movement on the thumb. The pupillary and extrinsic ocular movements are intact. The tendon jerks may either be increased or they may remain normal. The abdominal reflexes persist intact and the plantar responses also remain normal. There is no objective sensory loss but the patient may complain of fugitive paresthesiæ and of pains in back and shoulders. Gradually with the increase of muscular rigidity the activities of the patient are progressively restricted. The gait assumes a rapid short stepped character the so called festinant gait. The patient often breaks into a shuffling trot and unless he can pull himself up is apt to topple forwards. Occasionally also there is a tendency to step backwards in the same way. These phenomena are known as propulsion and retropulsion. The patient has difficulty in changing his position when sitting or lying in bed and may have to be moved at frequent intervals to relieve the numerous pains and discomforts which ensue from immobility. There is a clinical type in which tremor is the initial symptom and predominates throughout the course of the malady. Rigidity is present in relatively slight degree and the Parkinsonian facies may be late in appearing. In such cases the tremor is more ample and disabling than in the rigid cases.

Ultimately, the patient becomes bedridden and helpless. He tends to have periods of stupor, muscular rigidity renders mastication and articulation difficult and speech may become unintelligible. Sometimes despite Parkinson's dictum a progressive mental deterioration sets in and the last months of life are passed in stupor and anarthria.

When life is not cut short by some intercurrent affection the disease may take ten or more years to run its full course but comparatively few patients survive so long the majority dying of broncho pneumonia before the final stage with its mental hebetude sets in.

The characteristic lack of expression and of associated movements in the disease is largely, if not entirely due to the muscular rigidity which damps down and finally extinguishes all but the most essential and purely voluntary elements in movement. In a few cases rigidity reaches an extreme degree and tremor may be entirely absent, the so-called *paralysis agitans sine agitatione*. In other cases again tremor predominates and is free and ample in range while rigidity although always present in tremulous muscles is minimal.

Diagnosis —The onset is so gradual that the disease has usually been present for a year or more before recognition. In its initial stages it is most readily identified by the careful inspection of the patient as he approaches the examiner. In these circumstances the fixed, mask-like facies, the short stepped gliding gait, the immobility of the affected arm as the patient moves, and the slow dawning and passing of such expressive movements as the face may show, all go to make up a striking clinical picture, which is compounded of such slight deviations from the normal that a systematic examination of the patient may fail to reveal what has not been recognised at first sight.

The absence of qualitative alterations in the reflexes or of objective sensory loss are negative signs confirmatory of the presence of the disease.

A so called Parkinsonian state closely resembling paralysis agitans frequently follows recovery from an attack of encephalitis lethargica. The points of differential diagnosis are that in post-encephalitic paralysis agitans the patient may be of any age from early childhood onwards, tremor of the limbs is not so early nor so prominent a symptom, but there is usually tremor of the closed eyelids and of the protruded tongue, there may be anomalies of pupillary reaction and of ocular movement (loss of convergence and of accommodation), the skin of the face is greasy, and profuse salivation and dribbling are common. Frequently bizarre and complicated involuntary movements of face, tongue, trunk, or limb muscles are present, or striking disorders of respiratory rhythm and force. In many cases a history of an acute attack of encephalitis may be obtained.

Treatment —The steady course of the malady is uninfluenced by any known form of treatment. Subjective relief, and possibly some diminution of the degree of rigidity but not of the tremor are often temporarily obtained by the administration of tincture of belladonna or of stramonium (Mx increasing to Mxxx as tolerance is established) in increasing doses, of hyoscyne hydrobromide or of atropine sulphate in doses of from $\frac{1}{16}$ to $\frac{1}{8}$ gr by mouth three times daily. Pains and sleeplessness may have to be treated as they occur. For the rest, general tonic treatment and, in the later stages, careful nursing are indicated.

HUNTINGTON'S CHOREA

Huntington's chorea is a rare malady of middle aged and elderly persons, of slow onset, characterised by the development

of choreiform movements of head and neck face tongue, and limbs, and also by a progressive dementia. It is a heredo-familial disease may be traced through several generations and may occur in several members of a single generation. The movements resemble those of rheumatic chorea but are usually not quite so sudden and jerky. The facial involvement may be severe and articulation may become unintelligible. The dementia is progressive. Maniacal outbursts and suicidal tendencies are common.

The disease runs a steadily progressive course and recovery is unknown. When no heredo-familial factors are present we may speak of the condition as chronic progressive, or senile, chorea.

Under the name of "*apoplectic chorea*" we may mention a sequel of hæmorrhage into the region of the substantia nigra and corpus subthalamicum (subthalamic nucleus). The apoplectic seizure is followed by the development of intractable and severe choreiform movements of strictly unilateral distribution. Death from exhaustion after some weeks is the usual termination.

HEPATO LENTICULAR DEGENERATION

Progressive Lenticular Degeneration—This rare and fatal malady is characterised by the progressive development in adolescents or young adults of widespread tremor and rigidity of the musculature defects of articulation and deglutition, spasmodic weeping and laughing a slight degree of dementia and by the absence in uncomplicated cases of any true paralysis or of those changes in the reflexes associated with pyramidal system lesions. Pathologically, the nervous lesion consists in a bilaterally symmetrical degeneration of the lenticular (lentiform) nuclei, and sometimes of other regions of the brain and there is in addition portal cirrhosis of the liver. There may also be a deposit of pigment granules at the periphery of the cornea. It may occur in more than one member of a family. Its course is uninfluenced by treatment. It seems probable that the hepatic lesion precedes that of the brain.

CEREBRO VASCULAR DISEASE

(*Amaurotic Idiocy, Tay Sachs Disease*)

A rare familial form of progressive cerebral degeneration occurring chiefly in Russian Jews and characterised by

progressive paralysis and mental deterioration and by a peculiar form of macular change. Its causation is unknown.

Symptomatology.—The child is normal at birth and for some months subsequently. It then begins to become progressively weaker and apathetic and to show signs of visual impairment. Later, generalised muscular rigidity and blindness ensue, followed finally by coma, with or without convulsions, and death. Ophthalmoscopic examination reveals primary optic atrophy with a "cherry red spot" surrounded by a pale halo at the macula.

Morbid Anatomy.—Microscopic examination of the brain reveals extensive degenerative changes in the nerve cells and their processes, with a glial reaction. The retinal ganglion cells are similarly affected.

Other comparable familial forms (juvenile and adolescent) of progressive cerebral degeneration, with and without macular changes, and not confined to the Jewish race have also been described. There is no treatment for any of these conditions.

TOXIC ENCEPHALITIS

Acute inflammation of the brain occurs under varying conditions, and it may be suppurative or non suppurative. The suppurative variety is dealt with below under the heading of cerebral abscess. Of the non suppurative variety almost all cases are examples of virus infection of the nervous system, and these are dealt with under that heading on p. 830. There remain for consideration here rare cases of toxic origin.

Wernicke's Polioencephalitis Hæmorrhagica Superior—In this the symptoms are referable to a lesion of the periaqueductal grey matter, viz., ocular palsies, drowsiness and alternating paralysis. It is probable that this condition is a degenerative rather than an inflammatory process. There is a marked proliferation of small blood vessels, from which minute hæmorrhages occur, and also nerve cell degeneration and glial proliferation.

After the administration of the salvarsan products an acutely fatal encephalitis with convulsions and coma may ensue in cases of cerebral syphilis. In carbon monoxide poisoning also there may be cerebral lesions involving especially the globus pallidus and areas of demyelination of nerve fibres in the white matter.

Lead Encephalopathy may also be grouped in this category, but it is described on p. 940.

CEREBRAL ABSCESS

(Suppurative Encephalitis)

Pyogenic organisms may reach the brain by direct implantation in cases of injury to the skull and meninges, by direct spread from a local focus of suppuration, or by the blood stream from some remote focus of infection.

Traumatic Abscess, though frequent in gunshot wounds of the skull, is relatively uncommon in civil practice. Single or multiple abscesses develop in the track of the infective material.

Local Suppuration in the skull is the common cause of abscess of the brain and more than half the total number of abscesses seen arise in association with chronic otitis media. Caries of the petrous bone is the common antecedent of infection of the brain, and a cholesteatoma is found in most cases. Occasionally frontal sinus disease may result in abscess formation in the frontal pole of the hemisphere.

In the case of otitis media, either the temporal lobe (two thirds of the cases) or the anterior part of the cerebellar hemisphere (one third of the cases) is infected. In the former instance the tegmen tympani is carious, and a definite track may be traceable from the middle ear through the bone and dura into the brain. Occasionally a small abscess forms between dura and brain, but as a rule no definite track exists, and there is a thin layer of intact brain on the under surface of the lobe between abscess and meninges. When infection spreads through the posterior wall of the mastoid (tympanic) antrum the cerebellum is the seat of abscess formation.

Pyæmic Abscess.—In the majority of cases of pyæmia the brain is not infected, but there is a peculiar tendency to the formation of a single abscess in either frontal or occipital lobe in cases of chronic suppuration within the thorax (chronic empyema, bronchiectasis), and this is then usually the sole pyæmic manifestation. Surgical intervention in a case of chronic empyema is sometimes the immediate cause of abscess formation in the brain.

When the suppurative process develops very rapidly, the brain softens and becomes diffuent, suppuration reaches the ventricles or the surface, and death ensues within a few days. No definite circumscribing wall can be found to the necrotic purulent material. Clinically, a diagnosis of abscess cannot be made with a process so rapid, and symptoms of acute leptomeningitis may dominate the picture. With a more slowly

developing process an abscess cavity forms, and in from five to six weeks a definite enclosing capsule surrounds it. In long-standing cases this capsule may be extremely tough and thick, so as to allow of the abscess being removed intact. Further, such cases may run a long and latent course, the abscess suddenly bursting on to the surface of the brain or into the ventricles after a period of one or more years. This has been especially the case in abscesses forming in the track of a bullet.

Symptomatology.—As has been already mentioned, acute spreading suppuration so rapidly causes death with symptoms of an acute meningitis that a diagnosis of abscess cannot be made. In chronic cases a circumscribing capsule tends to localise the suppuration, and a well-defined abscess forms. It may give rise to three orders of symptoms: those of suppuration, those of a rise of intracranial tension, and focal signs determined by the seat of the lesion. Indications of a general septic process may be wanting, but when present consist of one or more rigors, a febrile reaction, and a leucocytosis in the blood. Pallor and progressive wasting may also occur in long-standing cases.

The symptoms of raised intracranial tension have already been dealt with under the heading of "Cerebral Tumour," and here, as in the case of tumour, depend for their intensity and time of appearance upon the rate of development of the abscess. In certain chronic abscesses there may be a period of over a year in which no symptoms whatever are present. In these circumstances, the bursting of the abscess into ventricles or on the surface of the brain is the first indication of abscess, and gives rise to acute and rapidly fatal symptoms: convulsions, coma, and death.

In the common case, that of otitic abscess, there is a period of from one to several weeks during which no definite symptoms are noticed. Then, headache, apathy passing into drowsiness, a subnormal temperature of about 97° F., and a slow pulse of from sixty to forty per minute indicate the slow growth of an encapsuled abscess.

Such a sequence of events in a case of chronic otitis media, or frontal sinus disease, should early give rise to a suspicion of abscess. In the initial phases, there is not often a complaint of failing vision, but examination will reveal an engorgement of the disc with haziness of its edges, or a frank papilloedema. Vomiting may occur, but is not prominent in every case. Focal symptoms in the case of temporo-sphenoidal abscess are determined by the spread of pressure to adjacent regions

of the brain. Thus pressure upwards will involve the lower end of the cerebral motor cortex and produce paresis of the lower face. Pressure mesially will affect the pyramidal system and produce hemiparesis in which the leg may be more definitely weak than the arm or face. Occasionally signs of midbrain compression are seen—paralytic dilatation of the homolateral pupil, ptosis and squint with diplopia. When the left temporal lobe is involved the disturbance of the speech function known as word-deafness may be present. An isolated external lateral rectus weakness with trigeminal pain in children with mastoid disease may be due to a localised meningitis over the petrous bone (*Gradenigo's syndrome*) and does not necessarily indicate abscess.

In cerebellar abscess the relatively small size of the posterior fossa of the skull tends to the early development of both general and focal symptoms. The most important of the latter are—

1 *Nystagmus*—This is most distinct when the eyes are turned towards the side of the lesion and then consists of a slow ample movement to the side of the lesion with a quick return. On deviation to the side opposite the lesion nystagmus may be less well defined and tends to be a more rapid and less ample movement than when the eyes are directed towards the side of the lesion. Nystagmus is not necessarily the earliest focal symptom present.

2 *Atonia and Ataxy* of the limbs on the side of the abscess. The arm musculature is flaccid and on movement the phenomena of cerebellar involvement described on p. 771 are seen.

3 *Paralyses of Cranial Nerves* third fourth fifth sixth seventh and eighth may be present on the side of the lesion but the localising value of these signs is less certain than those of cerebellar compression since some of them may be present as a result of middle ear disease (seventh and eighth) and a sixth nerve palsy occurs with raised intracranial tension in lesions which do not directly involve the nerve.

If diagnosis be not made at a time when atonia and slight inco-ordination of the limbs with or without definite nystagmus are alone present the progressive drowsiness of the patient will probably prevent adequate examination.

4 *The Cerebrospinal Fluid*—In most cases there is a moderate increase in the cellular and protein content of the fluid. Up to 30 cells per cubic millimetre may be found the majority being lymphocytes and not more than 5 per cent polymorphonuclear cells. When a subacute localised meningitis

develops, the cell count rises considerably higher but often remains predominantly lymphocytic, but with an acute spreading meningitis polymorphonuclear cells predominate

The chlorides and the glucose remain normal unless a meningitis supervenes when a drop in the percentage of both occurs

Diagnosis—Cerebral abscess may have to be differentiated from tumour, sinus thrombosis, and meningitis. In the case of pyæmic abscess the differentiation may be impossible apart from the history of the case and the presence of signs of chronic suppuration in the thorax. Thus the development of signs of intracranial hypertension after operation on a chronic empyema, or in a patient with bronchiectasis, is presumptive evidence in favour of abscess. The clinical signs of an acute infection of the meninges with the appropriate changes in the cerebrospinal fluid, and rapid downward course of the case usually serve to differentiate generalised meningitis from abscess. In *lateral sinus thrombosis*, signs of general septic infection are prominent repeated rigors, fever embolic phenomena, and rapid wasting. Headache, restlessness, delirium, vomiting, and even papilloedema may occur though no abscess be present. This combination of symptoms, associated with a normal cerebrospinal fluid, has been spoken of as "otitic hydrocephalus" and is treated by repeated lumbar puncture.

The Treatment of cerebral abscess is exclusively surgical, and in the absence of effective drainage, death is inevitable.

CHOREA

Under this heading are included two types of disease wholly unrelated in nature and incidence, but alike in that they are characterised by the appearance of involuntary movements, irregular and spasmodic in character, occurring during rest, and also superimposed upon voluntary movements which they render incoördinate.

The one is known as rheumatic or Sydenham's chorea, and is an extremely widespread malady of children dependent upon an infective inflammatory lesion of the brain, the other is a rare chronic, progressive malady of middle aged or elderly persons which, when it is associated with mental deterioration, is known as Huntington's chorea otherwise as chronic progressive chorea. It depends upon degenerative changes in the brain, and has been described already (p 813)

RHEUMATIC CHOREA. (*Sydenham's Chorea*)

Ætiology.—It is a disease of young persons, nearly all cases occurring between the ages of five and twenty years. Girls are affected more frequently than boys in the proportion of three to one, and it is most common amongst children reared under unfavourable hygienic conditions. It is essentially a manifestation of rheumatic infection of the cerebral hemispheres, and the subjects of chorea commonly give a history of other evidences of rheumatic infection—thus a history of acute rheumatism, ‘growing pains,’ of sore throat, rheumatic nodules, or erythema is obtainable in almost all cases. In a first attack of chorea it is not the rule to find objective evidence of rheumatic endocarditis, but in second and subsequent attacks signs of cardiac involvement are much more common.

Occasionally rheumatic nodules and fleeting joint pains of mild character may be noted during the course of an attack of chorea.

Predisposing factors in the subjects of the essential infection are a neuropathic inheritance, emotional instability, and debility.

Pathology.—The essential lesion is a disseminated meningo-encephalitis affecting the cerebral cortex, corpus striatum and pia arachnoid. The organism responsible for the lesion is in all probability the same as that which causes rheumatic carditis and arthritis. On microscopic examination changes closely resembling those found in lethargic encephalitis are seen.

Symptomatology.—The common mode of onset is subacute, and for one or more weeks before the appearance of the characteristic involuntary movements the child is noticed to be fretful, easily tired, and to be sleeping badly. Then a general motor restlessness is noticed, the child becomes fidgety, clumsy in movements, drops things, and knocks against the furniture in moving through the room. Obvious involuntary movements then appear, the patient grimaces, twists jerkily shrugging the shoulders and making sudden irregular movement of the head and limbs. These movements are increased in distribution and severity if the child be reprimanded, or has to carry out any purposive movement. Sometimes the articulation becomes disordered. Associated with these symptoms is a generalised muscular weakness, emotional instability, and in severe cases definite mental excitement and derangement.

The involuntary movements are true movements and not simple muscle twitches, they are rapid and variable in form. If the patient be asked to grasp the examiner's hand it will be

noticed that the muscular contraction is irregularly sustained and intermittent in character. In addition, adventitious movements of the arm at elbow and shoulder occur and the limb is jerked irregularly to and fro as the grasp is kept up. Further, the involuntary movements in other parts of the musculature are increased, so that the patient grimaces, and the head and lower limbs go into unceasing movement. The tongue, when protruded, is jerked back rapidly into the mouth, and cannot be withdrawn voluntarily into the mouth except in jerks. The respiratory muscles partake in the general disturbance, and the rhythm and force of respiration are irregular.

The movements may be predominantly unilateral, but are rarely absolutely so. For example, the facial musculature is always bilaterally affected.

The muscular weakness varies from case to case, and in some instances is the predominating feature of the condition, involuntary movements being minimal. This is the so called *chorea mollis*. The child lies limply on its bed, the musculature is profoundly flaccid, and all movements are performed feebly and readily cause fatigue. The reflexes are not qualitatively altered, though in the flaccid cases the tendon jerks may be diminished, or even lost. In some cases a peculiar phenomenon is seen on eliciting the knee jerk with the leg slightly flexed. The leg rises from the bed and remains suspended in the air for a second or so before flopping back on to the bed, owing to the imposition of a choreic upon the reflex movement. The abdominal reflexes are retained and the plantar responses are of normal type.

Although in first attacks of chorea definite evidence of rheumatic affection of the heart is frequently absent, yet slight dilatation and rapidity of the heart are common. In recurrent attacks endocarditis is often found.

In a large number of subjects second and third attacks occur at intervals of several months.

Chorea may be met with in young women during their first pregnancy, the symptoms developing during the first three months and often becoming extremely severe. Added to a continual motor restlessness there may be active delirium and considerable weakness. Death may occur from exhaustion. It may recur in subsequent pregnancies.

Course.—The duration of a case of average severity ranges from six weeks to several months. The longer course is seen in the absence of adequate measures of treatment and management. Sometimes temporary improvement or apparent recovery may be followed by recurrences, and thus the disease

spreads out over a long period. Death from exhaustion occurs in a small number of cases, usually when the patient is adolescent or a pregnant woman. Rheumatic heart disease may also be responsible for a fatal issue.

Diagnosis—The two maladies with which Sydenham's chorea are most likely to be mistaken are multiple tics and the choreiform type of lethargic encephalitis. In the former case, the involuntary movements tend to be repetitive and peculiar to any given case, and cease in an affected limb when this is in voluntary use. There is no dysarthria, nor does the subject drop objects from the hands. The tic-like movements may persist for years or may suddenly change in form. In lethargic encephalitis the onset of choreiform movements is usually sudden, and there are associated ocular palsies, ptosis, squint and diplopia. Slight fever, disturbances of sleep, and nocturnal delirium may also occur.

Treatment—In cases of recent onset and of all grades of severity rest in bed under conditions of reasonable quiet is essential. The period of rest varies with the severity and with the rapidity of response to treatment. Separation from other children is advisable but it is necessary to keep the patient contented and quietly amused. Since the subjects of chorea are frequently debilitated and badly nourished, their feeding must be carefully attended to. In profoundly restless cases nasal feeding may be necessary, and in these circumstances particular efforts must be made to maintain nutrition as far as possible. When the movements are violent, the patient must be protected from injury by pillows arranged round the bed and by cotton wool and bandages round the limbs.

In the matter of drugs aspirin is the most useful agent and is well tolerated by patients with chorea. For children from five to fifteen years of age 10 gr. three or four times daily may be given and 15 gr. for older patients. If this does not suffice to procure sleep, luminal or chloral and bromide may be given at night. In severe or resistant cases the addition of chloretone (5 gr. twice daily for a child of ten and for a limited time) may be beneficial but it should not be used as a substitute for aspirin.

During convalescence general tonic treatment is indicated. Cod liver oil and malt, syrup of hypophosphites, iron and arsenic may all be usefully employed.

DISSEMINATED SCLEROSIS

Clinically, disseminated sclerosis is a malady of otherwise healthy young adults, usually characterised by an intermittent

course which depends upon the acute development at irregular intervals and in various parts of the brain and spinal cord of multiple inflammatory foci. These lesions give rise to acute outbreaks of symptoms with intervals of improvement and quiescence.

Ætiology.—Nothing certain is known of the causative agent in this disease. The fresh lesions are undoubtedly inflammatory in nature, but whether an organism or a circulating poison is responsible is unknown. It is essentially a malady of early adult life, its onset being rare before sixteen years of age or after forty-five. Females are more frequently affected than males, in the proportions of five to two. It is found with equal frequency in urban and rural dwellers and in persons of all social grades and modes of life. In this country it is now the commonest organic nervous disease, exceeding neurosyphilis, and is still increasing in frequency. Various factors have been invoked as either causative or precipitating, but with no convincing evidence. Thus, it may first become apparent after pregnancy and parturition, after trauma or after infectious illnesses, but some at least of its principal symptoms are so insidious in onset that these alleged relationships can never be established satisfactorily.

Morbid Anatomy—The primary lesion is one of medullated nerve sheaths within the brain and spinal cord, with associated secondary neuroglial and vascular reactions. The foci of the disease are scattered thickly throughout the nervous system, being usually most abundant immediately beneath the cerebral cortex and beneath the ependymal lining of the ventricles, and spread at random throughout all parts of the brain stem and cord. The cerebellum is less thickly sown with patches of disease than the rest of the nervous system. The lesions vary in size from microscopic foci to patches of one or more centimetres in diameter. They are sharply delimited from normal tissue and are wholly irregular in outline, invading grey and white matter indifferently.

The optic nerve is very commonly the seat of one or more lesions. The myelin sheaths are early destroyed and the axon cylinders stripped. The former degenerate into fatty droplets and the latter may be distorted. Neuroglial reaction is present, and varies in appearance and intensity according to the age of the lesion. Nerve cell bodies included within a patch undergo some chromatolysis, but are much less severely affected than the nerve fibres. To the naked eye a fresh patch has a pinkish swollen, translucent appearance, but old patches are grey and sclerosed.

Symptomatology—The clinical course of the disease may usefully be divided into three stages—the stage of evolution, the stage of full development, and the final stage.

The stage of evolution may be long drawn out, and it is frequently ten years before the malady is fully developed. The initial symptoms are of two orders—those referable to lesions of the spinal cord and those due to lesions in the brain stem and optic nerves. The spinal cord symptoms are usually very slow and insidious in onset, and have been present in most cases for one or more years before the subject seeks medical advice. They consist in a slowly developing weakness of one or both legs which is first manifested as undue fatigue on walking and then by actual dragging of the foot or feet when the subject is tired. This slow progress may be interrupted by a sudden marked exacerbation of weakness in one leg, which makes unassisted walking impossible for a week or more and then slowly clears up, leaving a variable degree of residual weakness behind. It is not uncommon for the initial symptoms to be regarded by the patient as due to some local disorder of the leg or foot such as "rheumatism," "sprain," or "displaced cartilage of the knee" until after a year or more the increasing severity of the disability leads the doctor to question the patient's diagnosis and for the first time to make an adequate clinical examination.

The upper limbs are peculiarly prone to sudden temporary accessions of what the patient describes as "uselessness," which are found on examination to consist of severe ataxy due to impairment of the sense of position and rarely to true motor weakness.

Punctuating this course of events, or even preceding it by one or more years, there occur striking symptoms of acute onset referable to the optic or oculomotor functions. Transient blindness or severe impairment of vision in one eye, of rapid onset, of one or two weeks duration, and followed by complete or almost complete restoration of vision, or transient diplopia without unequivocal squint are the characteristic expression of these lesions. This impairment of visual acuity is the result of retrobulbar neuritis (see p. 879). At the time when the disturbance is first noted ophthalmoscopic examination is negative though rarely a slight oedema of the optic disc may be noted. The temporal pallor which ensues is not present for some weeks later. These may recur at intervals affecting first one eye and then its fellow. At this stage of the disease nystagmus, scanning speech, and intention tremor are quite exceptional except in those few cases in which the cerebellar

projection fibres in the brain stem are involved early and severely. These three symptoms, the so called triad of Charcot, are commonly symptoms of the fully developed disease, and are not constant even then. They are not essential to a diagnosis of the disease, and if they are so regarded its recognition must always be unwarrantably delayed. Fleeting pains of moderate degree in back and limbs and paræsthesiæ in the extremities are common.

During the ten or even more years that this slow and variable progress of the disease goes on the patient may have intervals of several years of apparently quite perfect recovery, in which even objective physical signs may be difficult to find. The fugitive character of signs and symptoms has given rise to the view that hysterical phenomena are common concomitants of early disseminated sclerosis and many early cases of the malady are regarded as hysteria when a careful history is not taken and no opportunity occurs of examining the patient during the transient presence of the disabilities complained of. The slight emotional facility which many patients show is an added basis for this belief. In exceptional cases no remissions occur.

Examination during the stage of evolution reveals in most cases an absolutely typical group of physical signs. The tendon reflexes are exaggerated, and there may be unilateral or bilateral ankle clonus, the plantar responses are of the extensor or Babinski type on both sides, the abdominal reflexes are commonly absent, and the legs may show a minimal degree of spastic paresis. Although the disability of the limbs complained of may be one sided, examination commonly reveals bilateral physical signs. In addition, there may be pathological pallor of the temporal halves of one or both optic discs and a loss of vibration sensation in the legs. This group of signs, in the absence of cutaneous sensory loss, is an adequate basis for the diagnosis of the disease. Other signs may sometimes be added to these, including nystagmus, slight intention tremor of the hands, and some ataxy of gait (due to impairment of the sense of position in the legs).

In the stage of full development there is definite spastic paresis of the legs, and the patient may be bedridden or require assistance in walking. Flexor spasms in the legs have begun to occur, and precipitancy and even incontinence of urine. The arms may be ataxic or show that form of unsteadiness on purposive movement known as intention tremor. Nystagmus and a peculiar spacing of syllables in articulation may be present. By this time there is a severe degree of permanent

unvarying disability, and remissions of any great degree have ceased to occur. Finally, after a varying period of years flexion contracture develops in the legs, with profound loss of voluntary power, the sphincters act involuntarily, the arms are unsteady, the articulation grossly disordered, and tremor of the head and trunk may accompany all attempts at movement. In addition the patient is very euphoric and fatuous, having little insight into the severity and hopeless nature of his condition. Occasionally gross symptoms of mental disorder of variable character may be present. Death ensues from some intercurrent infection, pulmonary or urinary, or by septic absorption from bed sores.

In some cases the progress of the disease is indefinitely arrested in the earlier stages, and the patient continues to lead a restricted life for many years.

Characteristic of the malady in most instances is the absence or late appearance of cutaneous sensory loss. Loss of the sense of position in the limbs and of vibration sensation is common.

The blindness which may occur as an incident in the disease is never permanent, though an attack of retrobulbar neuritis from development of a patch of disease in the optic nerve may leave some degree of visual impairment and a marked degree of pallor of the discs. Permanent paresis of cranial nerves is also exceptional.

Cerebrospinal Fluid—In about 50 per cent of cases, there is a slight mononuclear lymphocytosis, little or no protein increase, a negative Wassermann reaction and a "paretic" type of Lange colloidal gold curve. For further details on the last named reaction the reader is referred to p. 848.

Diagnosis—Although it may be difficult an accurate diagnosis can usually be made even in the earliest stages of the malady. The typical combination of history and signs are not found in any other malady. The gravest difficulties arise in those cases where transient blindness precedes all other signs and symptoms. The patient is usually a young woman in whom, during the course of a few days, vision has rapidly failed in one eye, being reduced to appreciation of hand movements. Examination of the fundus oculi reveals nothing whatever abnormal until several weeks have elapsed and after visual acuity has been restored. Despite the extreme rarity of retrobulbar neuritis from sphenoidal sinus infection and its extreme frequency in disseminated sclerosis, a diagnosis of sinus infection is usually made in cases of the kind and the inevitable restoration of vision is attributed to whatever

operative procedures may have been adopted to drain the sinus. The patient at the time may present no objective signs of any nervous system disease, a fact which probably accounts for the continued non recognition of this symptom as a common initial manifestation of disseminated sclerosis, sometimes preceding all other symptoms by periods ranging from a few weeks to fifteen years, or occasionally longer.

Another fruitful source of error is provided by cases in which the signs and symptoms suggest a focal lesion of the spinal cord, with cutaneous sensory loss up to a segmental level. In these cases the presence of exaggerated tendon reflexes in the arms, of pallor of the discs, of slight nystagmus and of an indistinctness or variability in the upper level of sensory loss should always give rise to suspicion as to the true nature of the condition present. Further, examination of the cerebrospinal fluid may serve to differentiate compression of the cord from *disseminated sclerosis, in which disease the fluid may be normal in the early stages or present no other abnormality than a slight lymphocytosis and slight increase of protein and is always colourless and clear*.

In other cases again, ataxic symptoms and disturbances of ocular movement may precede definite indications of pyramidal tract involvement and a diagnosis of focal pontine or brain stem lesion may be made. In the great majority of cases, however the combination of signs given above as characteristic of the stage of evolution is present and makes a correct diagnosis possible.

Prognosis—Although disseminated sclerosis is a progressive malady ending in most cases in profound disability, yet nothing can be more difficult than to give a prognosis in an early case. This is especially so when we remember that retrobulbar neuritis is commonly an initial symptom occurring sometimes years before any other manifestation of the disease develops. In other words, a young person with a unilateral retrobulbar neuritis may have an unknown period of normal health before her, ranging from weeks to years. In such circumstances the greatest caution in giving a prognosis to the patient or her relatives should be observed and unwise generalisations as to the advisability of marriage, for example should out of ordinary humanity be avoided, and not offered uninvited.

Once symptoms referable to a spinal cord affection have made their appearance a graver prognosis as to the possible duration of wage-earning capacity is justifiable though even here long remissions are not rare and the future depends in some degree on the nature of the patient's work. hard physical

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work being more likely to have adverse results than purely sedentary work. Very many subjects of disseminated sclerosis do in fact remain at work for years after the nature of their illness is declared. Perhaps there is no malady in which the future of the individual patient is more difficult to forecast, and no situation in which an economy of speculation is more necessary.

Treatment—There is, unfortunately, no method of treatment which is known to influence the course of the malady, and this course is so capricious and the occurrence of long remissions so common that the assessment of any mode of treatment is extremely difficult. In the circumstances it is not surprising that extravagant claims are made from time to time in favour of this or that mode of treatment by those not familiar with the natural history of the disease.

Amongst recent methods for which favourable results have been claimed are protein shock therapy, pyrotherapy, electrotherapy and liver treatment. In respect of none of these is there available any sound evidence of their efficacy.

It has long been known that fever occurring during the course of disseminated sclerosis affects it adversely, and it is not clear that artificially produced fever is free from the same danger.

It cannot be said that the traditional practice of giving arsenic (either by mouth or by the injection of organic compounds) has ever justified its use, and the same may be said of the other anti-syphilitic drugs which have been employed.

Recently, the use of quinine (quinine hydrochloride 5 gr. twice daily) has been advocated. Here again the proof of its value is yet to be established, but the drug produces no harmful reactions and it is worthy of trial.

Perhaps more important than any formal method of treatment is the right ordering of the patient's life when this is practicable. All forms of fatigue must be carefully avoided and their inadvertent occurrence must be dealt with by corresponding rest. Infectious illnesses, trauma, and other forms of stress all have a deleterious influence on the course of the malady. Although it is not usual for the symptoms to increase should pregnancy supervene in the patient, yet delivery is often followed by an exacerbation of the malady, which may even first come to notice in these circumstances. The presence of disseminated sclerosis is not in itself an indication for any intervention in the course of a normal pregnancy, but only for greater care of the patient during this period. Indeed, the artificial termination of pregnancy is sometimes as disastrous as a full term confinement. Should an outbreak of symptoms

occur, the patient is best kept in bed for two or three weeks, with massage to maintain the muscular condition. While any obvious focus of gross infection may usefully be dealt with as an adjuvant to treatment, it is unwise to expect such measures to have any material influence on the course of the disease, and indeed meddling therapy of this order may even be harmful in the reactions it provokes.

ACUTE DISSEMINATED ENCEPHALOMYELITIS AND NEUROMYELITIS OPTICA

The relation of these two maladies to each other and of each of them to disseminated sclerosis is not yet certain. All three are essentially demyelinating diseases, but those two now under consideration are more acute and severe in the lesions associated with them.

In the brain the lesions are mainly confined to white matter. They are small and multiple. Not only may the myelin sheaths be destroyed, but the axis cylinders also, while there may also be glia cell degeneration and tiny areas of softening and even of cavitation. In neuromyelitis optica or Devic's disease as it is also called, the optic nerve is similarly affected. These maladies occur at all age periods.

Neuromyelitis Optica—The symptoms are those of a transverse myelitis of rapid onset and of a retrobulbar neuritis (central scotoma and even complete blindness, cedema of the optic discs). The myelitis may precede or may follow the retrobulbar neuritis, and an interval of months may separate them. The paraplegia is often total, and may ascend for a time, so that respiratory failure and death may ensue. On the other hand, recovery may occur. Vision may be almost completely restored, but some defect commonly remains, and after the lapse of some months the characteristic pallor of primary atrophy appears.

The cerebrospinal fluid may show an increase of lymphocytes (up to 50 to the c.c.).

Treatment has no influence upon the disease process, and the care of the patient is that of any case of paraplegia.

Acute Disseminated Encephalomyelitis—The symptoms may be those of an acute and severe disseminated sclerosis. There are headache, sickness, and vertigo, sometimes stupor or delirium. There may be weakness and unsteadiness of the limbs with the reflex changes characteristic of pyramidal lesions. Recovery or death may ensue.

As for neuromyelitis optica there is no specific treatment.

THE VIRUS DISEASES OF THE NERVOUS SYSTEM

(Poliomyelitis, Encephalitis, Herpes Zoster, Rabies)

Under the heading of virus diseases we must include poliomyelitis epidemic encephalitis, the encephalitis and myelitis that may follow vaccinia and the acute specific fevers, rabies and also herpes zoster

Owing to their affinity for the nervous system the viruses in question are known as neurotropic and since they act primarily upon the nerve cell they are also spoken of as polioclastic. They multiply and exert their pathogenic activity only in contact with the living cell, within which their life and activity are short lived. After a short period they disappear, and thus virus diseases are said to be self limiting.

Clinically they produce an encephalitis or a myelitis according to the part of the nervous system upon which they act, or more precisely the part in which their action predominates since both brain and cord involvement are present in them all. The vascular and glial reactions which may be associated with the nerve cell lesion are secondary, and are not, as used to be thought—at least in the case of poliomyelitis—a preliminary to nerve cell involvement.

In all cases the virus is to be found only in the nervous tissues and not in blood or cerebrospinal fluid—that is to say, the virus infections are primary infections of the nervous system and not generalised systemic infections.

In rabies, infection follows a bite by a rabid animal, the virus entering a local nerve ending (see p. 205).

POLIOMYELITIS (*Infantile Paralysis*)

It was formerly held that there were three distinct stages in the evolution of this disease—a stage of general infection, a stage of invasion of the subarachnoid space (with infection of the cerebrospinal fluid), and a final stage of invasion of the nervous system. It was thought that the virus gained access to the cerebrospinal fluid by travelling up the perineural lymphatics of the olfactory nerves, and that it spread within the subarachnoid space and thence infected the spinal cord.

It is now believed, as the result of recent investigations that from the outset poliomyelitis is an infection exclusively

of the nervous system, and all the symptoms of the disease are due to the action of the virus upon nerve cells. It would thus appear that the virus is already established within the nervous system when the first symptom develops.

The disease occurs sporadically and in epidemic form, and appears usually in the late summer and autumn. Both rural and urban communities are liable to epidemic invasion. Within the past twenty five years, severe epidemics have occurred in the United States in the Scandinavian countries, and in Australia. Fortunately there have been no serious outbreaks in Great Britain.

Ætiology—The responsible organism is one of the smallest filterable viruses known. Man and the chimpanzee are the only natural hosts, though other monkeys can be successfully inoculated. Under experimental conditions the disease can be conveyed by inoculation through the cerebral, intranasal, tonsillo-pharyngeal, vitreous and intestinal routes; the tonsillo-pharyngeal being the most uniformly successful. This fact is significant when we recall that cases of the bulbar type of poliomyelitis may occur, during epidemics of the disease in children subjected to tonsillectomy or adenoidectomy.

The view formerly held that the habitual portal of entry of the virus into the nervous system in man was the olfactory one, namely, from the nasal cavity via the filaments of the olfactory nerves into the brain, has lost ground since recent histological investigations have failed to find the characteristic tissue reaction to the entry of the virus in the olfactory bulbs or tracts. Further the presence of virus in the stools in human cases and in the gut wall in the experimental disease has led to the suggestion that the alimentary tract may provide the common port of entry—the pharynx in bulbar and the bowel in spinal cases. It is suggested that the virus passes thence by sympathetic nerves into the spinal cord.

Further, since the virus can by means of monkey inoculation experiments be detected in the stools not only during the acute illness but also for some weeks afterwards, the belief that chronic carriers do not occur in the case of poliomyelitis appears to be invalid. Unfortunately no ready means of detecting carriers exists, for there are no specific precipitin complement fixation or cutaneous tests for poliomyelitis.

There is no conclusive evidence that the virus can infect or multiply in extraneural tissues and therefore the present view that poliomyelitis is an exclusively nervous system infection still holds.

The incubation period is believed to be from five to twelve days.

Epidemiology—The researches of Wickman in the Swedish epidemic of 1905 demonstrated that poliomyelitis is a human borne contagious affection, spread taking place along the lines of human communication.

Two types of individual carry and spread the infection, the healthy carrier of the virus and patients suffering from the disease in its so called abortive forms and in the pre paralytic stages. It is clear, also, that even paralysed patients during the first two weeks of the illness are infectious, though once paralysed their opportunities of spreading the malady are restricted. Active virus has been detected in sewage coming from a focus of infection. Otherwise nothing definite is known as to the carriage of the virus by non human agencies, such as insects or animals but the possibility of such non human spread is not yet excluded and in at least two outbreaks it has seemed probable that milk acted as a vehicle of spread. This or some comparable mode of spread, may be responsible for those epidemics which begin suddenly and show indications of widespread simultaneous infection of large numbers of persons.

It is probable that the infectivity of the disease varies from epidemic to epidemic, and there seems to be a high degree of natural resistance in the community. This may in part be an acquired immunity on the part of individuals who in infancy have suffered from an unrecognised abortive attack of the disease. A single attack gives permanent immunity to the individual. Protective antibodies have been found in adult human serum in 70 per cent of all sera tested though whether this depends upon a prior non paralytic attack of the disease or not is not certain.

Pathology.—The primary and essential lesion of the disease is in the nerve cell, and the virus appears to have a special affinity for the large cells of the ventral horns of the spinal cord especially in the lumbar region. The lesions vary from chromatolysis to complete necrosis. Immediately following this an inflammatory reaction with exudate appears in the interstitial tissue of the neighbouring grey matter, in the perivascular spaces and in the meninges. This reaction in turn leads to alterations in the cerebrospinal fluid. It was formerly thought that this reaction and the resulting change in the fluid were all precursors of the cell lesion but it is now known that they are consequences of the latter. Although the nerve cell lesions which lead to paralysis are those in the brain stem and spinal cord an encephalitis is an essential element in every case of the disease, even in those in which

paralysis does not ensue. The virus and the reaction it produces are invariably present in the motor cortex, thalamus, vestibular and cerebellar nuclei.

Symptoms—The clinical course may be divided into three phases, it being borne in mind that each of them results from the action of the virus upon nerve cells. *The first phase* is characterised by fever (103° to 104° F) and by a peculiar and characteristic condition of the child, who is flushed, apt to be irritable and apprehensive. Those who are familiar with epidemic outbreaks of poliomyelitis state that this aspect of the picture marks out the disease from the other infectious fevers of childhood. In severe cases the child may be restless, his movements are jerky, and irregular tremors are seen from time to time.

The second phase succeeds in a few hours and to the previous symptoms are now added localised pains in back and limbs, muscular tenderness, stiffness of the neck and back, unsteadiness of movement and weakness.

The third phase, that of paralysis, then develops suddenly, generally within one to three days from the original onset of symptoms.

It has long been known that in epidemics of the disease a proportion of patients make a recovery before the appearance of the third stage. These non-paralysed cases are spoken of as "abortive cases." In these the virus has been neutralised by the natural resisting agencies in the body before it has been able to damage the ventral horn cells sufficiently to produce paralysis. It is not correct to regard them as cases in which the virus has not succeeded in gaining access to the nervous system. It is believed that as many as 70 per cent. of all infected children during an epidemic may escape paralysis in this way.

It has in the past been customary to speak of cerebral, cerebellar, brain stem, spinal and neuritic types of poliomyelitis, but it is highly probable that all but the brain stem and spinal forms of paralysis are not due to infection by the virus of poliomyelitis, but constitute a mixed group of infections of varied and unknown origin. We shall therefore only consider pontobulbar and spinal paralyses.

The paralysis may vary from weakness of a single muscle to widespread paralysis of limb and trunk musculature. When the paralysis is limited in extent the deltoid and the dorsal flexors of the foot and toes are especially prone to be picked out, but there may be extensive paralysis of one or more limbs, with or without involvement of abdominal, back, neck, and

thoracic muscles. As a rule the paralysis is maximal in degree and extent at the moment of onset, but in ascending paralysis, or the spread at short intervals of paralysis from limb to limb, may occur. Ascending paralysis terminating in involvement of the respiratory muscles and death within a period of hours is more common in cases occurring during epidemics, especially in adult patients. Of the total number of muscles involved, some are totally paralysed and a greater number weakened. In a few cases there is a widespread slight paresis of muscles, which is apt to be regarded as a general debility following the febrile constitutional disturbance which precedes it. Similarly, cases in which paralysis or paresis is restricted to the back or abdominal musculature may escape diagnosis. For a period varying from one to several weeks some or all of the affected muscles may be painful and extremely tender on manipulation. When these symptoms pass off the patient is said to have entered the convalescent stage of the disease.

Wherever there is an appreciable weakness of a muscle the corresponding tendon jerk is greatly diminished or abolished. Sensory loss does not occur, and the only sphincter disturbance is a temporary retention of urine which rarely lasts for more than two or three days.

When the period of convalescence is entered, the affected muscles may be divided into those which recover rapidly and completely, those which make a gradual and partial recovery, and those which remain permanently paralysed. The last two groups undergo progressive wasting, and in severe cases extreme and widespread muscular atrophy may ensue, with defective growth of the affected limbs subsequently. Under adequate treatment some degree of progressive improvement may go on for two or even three years. After this period, no further improvement can be expected.

In the process of wasting, fibrous tissue forms in the muscles, and unless appropriate measures are taken from the outset may result in considerable deformity of the affected region.

The Cerebrospinal Fluid—The examination of this fluid is of great importance if a diagnosis is to be made during the preparalytic stage of the disease. The fluid may be normal during the opening hours of the first phase, but as the second phase is reached the cellular content rapidly increases. At first polymorphonuclear cells predominate (from 30 to 2000 per c c), and when the count is high the fluid may be opalescent. Very soon the proportion of lymphocytes increases and towards the end of the febrile period they outnumber the polynuclear cells. The globulin content of the fluid is raised, but the

chlorides and glucose remain unchanged After the appearance of paralysis the fluid soon resumes its normal composition

These changes in the fluid were formerly thought to express the invasion of the subarachnoid space by the virus, and to precede the invasion of the nervous tissues It is now known, however, that they follow and are a consequence of the pathogenic activity of the virus within the nerve cells

Treatment—This includes (i) measures intended to cut short infection before the nerve cells have been irreparably damaged, (ii) measures to prevent the spread of infection to susceptible persons, and (iii) measures for dealing with paralysis when this ensues

It has long been known that the serum of persons who have survived an attack of poliomyelitis, so called 'convalescent serum,' has the power of protecting that susceptible animal, the monkey, from infection under certain conditions These conditions are that serum and infective material are inoculated together into the animal, or that the serum is given not later than twenty four hours after inoculation with infective material On the other hand, if any symptoms of poliomyelitis have appeared in an infected animal, it is then useless to give serum, since it neither cuts short nor mitigates the severity of the disease

Although this observation should have warned us to expect little from the serum treatment of poliomyelitis in man, since serum can never be administered until symptoms appear, yet for over twenty years this treatment has been in use and many striking claims have been made for its efficacy It is said, when given in the preparalytic stage, to have prevented the appearance of paralysis in some cases, and to have reduced the extent and severity of paralysis in others

Within the past few years the attempt has been made to see whether these claims can be accepted, and it is now generally agreed that there is no clear evidence that at any stage of the disease the use of serum has any influence upon its subsequent course In some extensive epidemics in the United States half the patients seen in the preparalytic stage of the disease were given serum, and in half the cases it was withheld Those not given serum fared as well as those who received it

The nasal instillation of a 2 per cent solution of potassium chlorate has been advised as a prophylactic in susceptible contacts, and the oral administration of the same drug as a means of combating the infection in its preparalytic stage For the latter purpose as much as 5 gr for an infant and 50 to 70 gr for adults—this dose being spread over a twenty four hour period—have been recommended This dosage is continued

for a maximum of four or five days, and for less if the temperature falls to normal earlier. Full confirmation of the value of these procedures must wait upon further experience, but in the view of the crippling effects of poliomyelitis a trial of them is worth consideration.

In short, there is so far no known method of cutting short the infection. Since we are dealing with a nasopharyngeal infection in which the secretions are infective for some days before and after the appearance of paralysis, cases coming under observation during this time should be dealt with accordingly, and treated as any other infectious disease. In the American epidemics strict isolation is practised, but in this country, owing to the fact that clear clinical evidence of case to case infection is scanty, a less rigorous isolation is adopted. Whether antiseptic douching of the nasopharynx is of value is doubtful, but its use may serve to impress the infective nature of the malady upon the patient's attendants. Potassium permanganate solution may be used. From what has been said of the common presence of the virus in the stools and from the possibility that it may persist for some weeks the stools should be dealt with as in the case of typhoid. The bedpan when one is used and the bed linen should be treated on the same lines.

The only indication for drugs is pain and for this purpose aceto-sabyleic acid is generally adequate.

The most arduous part of treatment is that of the paralysed muscles. To be effective it must be continued in severely paralysed cases for a very long period, and some general principles only can be formulated here. The three essentials are muscular rest, the maintenance of good posture, and re-education exercises. While pain persists, rest and the maintenance of physiological posture are the only justifiable measures and massage and electrical stimulation are absolutely contraindicated. From the moment that paralysis develops the affected muscles must be kept at rest in a position of relaxation. The legs must be extended adducted, and rotated in so that the feet lie side by side. For this purpose the use of pillows, sandbags, and of simple splinting with cardboard and bandages generally suffice. Plaster bandages are rarely necessary and if applied should be regarded as a temporary measure. Similarly, the hand should be kept in the mid position and the shoulder abducted when the deltoid is affected. If the erector spinae (*sacrospinalis*) be involved, the patient must be kept in the supine position for several weeks and not allowed to sit up until a mechanical support has been prepared.

These measures to secure relaxation and to prevent stretching of the paralysed muscles must be maintained indefinitely but prolonged immobilisation is undesirable. As soon as possible when suitable mechanical support has been provided the patient should be got on his feet whenever possible and except in the most extensively and profoundly paralysed cases this can generally be done. Re-education exercises now become of value. These consist in assisted active movements of the weakened muscles in which the movement is attempted with the muscle almost in the position of greatest shortening that is to say a full excursion of the limb is not attempted. By varying the patient's position and by giving active help the weight of the limb is taken off the muscle and the action of gravity overcome. Such movement should be undertaken daily for short periods fatigue being carefully avoided. With returning power less active assistance is required. Walking exercise with a walking chair must be employed when possible.

Massage takes a secondary place in treatment and is most useful for those muscles which being totally paralysed cannot be dealt with in any other way. It must never be regarded as an adequate substitute for active exercises. Despite a widespread belief to the contrary there is no unequivocal evidence that any form of electrical stimulation is of the slightest use in assisting in the recovery of power in paralysed or weakened muscles and its employment is harmful in that it tends to replace rational and useful modes of treatment. Moreover the use of powerful currents by inducing contraction in normal muscles tends to aggravate the tendency to deformity and to stretching of weakened muscles.

When during the acute stage paralysis invades the respiratory muscles death may ensue from asphyxia. To tide the patient over this peril the use of respirators has been adopted. These are of two types the box respirator of Drinker type in which the patient is enclosed his head protruding at one end of the box through a rubber collar round the neck. A motor produces rhythmic positive and negative pressures within the respirator and the chest is passively moved. In the Bragg Paul type a rubber bag encloses the patient's thorax and is rhythmically filled and deflated by means of a motor and the chest thus rhythmically compressed and released. Experience has not altogether confirmed the over-enthusiastic claims made for these devices. For cases in which the main lesions are bulbar and respiratory difficulty arises from involvement of the respiratory centre their use is strongly contraindicated.

and the careful clearing of the air passages from accumulating secretions is essential. In respiratory muscle paralysis, the apparatus is of value in those exceptional cases in which this paralysis is transient. Too often these muscles do not recover, and permanent confinement in the respirator is then inevitable or the measure of recovery obtained is minimal and leaves a permanently helpless and bedridden patient. In short, the maximal usefulness of the respirator is not for cases of poliomyelitis but for such conditions as coal gas poisoning where recovery may be anticipated if death is averted.

The outbreak of an epidemic of poliomyelitis in a school presents problems of some difficulty. Clearly, the closing of a day school is imperative but it has been urged that this step in the case of a boarding school necessitates the dissemination of a number of possible carriers and incubating cases and may thus lead to further spread of the disease.

On the other hand, the occurrence of case to case infection is established beyond reasonable doubt, and within the school community fresh cases may continue to break out for several weeks. In other words, every healthy child retained within such an infected community remains exposed to infection with its frequently disastrous consequences. There can be no justification for exposing a number of children to this danger. The safest plan, therefore, is probably the disbandment of the school and the segregation of exposed children within their own homes for a period of two weeks care being taken not to allow them to come in contact with other children in the household.

LETHARGIC ENCEPHALITIS (*Epidemic Encephalitis*)

This malady occurs sporadically and in epidemics, but evidence of the infectivity of cases is uncertain and its mode of spread is unknown. Multiple cases in a household are extremely rare. No age is exempt from susceptibility to the disease. During the few years which have elapsed since its recognition the clinical picture of the malady has varied considerably in different outbreaks and has not always conformed to that by which it was originally identified.

Ætiology—The disease is believed to be due to infection by a specific virus, which so far has been neither observed nor cultivated *in vitro*. It is not yet certainly established that the disease can be transmitted to animals by the inoculation of brain substance from fatal human cases.

Morbid Anatomy.—Multiple small meningeal hæmorrhages are sometimes seen over the cerebral hemispheres. Microscopically, a widespread inflammatory reaction and extensive neuronal degeneration are found. In rapidly fatal cases the former may be slight, but in cases of longer standing it dominates the histological picture. Although diffuse, these changes tend to be most profound in the region of the basal ganglia and brain stem, and the melanin containing nerve cells of these regions seem to suffer most severely.

The inflammatory reaction consists in congestion of blood vessels of all sizes, of minute hæmorrhages scattered throughout the brain substance, and of the characteristic perivascular infiltration by lymphocytes and—in smaller numbers—by plasma cells. Numerous lipid granules, the products of nerve cell degeneration, are also seen in the perivascular spaces.

The cerebrospinal fluid may be normal but when altered shows a lymphocytosis with normal protein and glucose contents. Up to one hundred cells per cubic millimetre may be present.

Symptoms—The great number of symptoms and the various combinations and sequences in which they may occur make a clinical description of the malady somewhat difficult. We may divide them into constitutional and nervous symptoms, still further subdividing the latter according to their nature and localising significance.

The constitutional symptoms vary greatly in severity and duration. They may be so trivial as to escape notice, or so profound as to induce a typhoid state, ending in death after some weeks. In its commoner and mild form this phase of the malady consists in a febrile illness of some few days' duration, the symptoms being headache, malaise, minor gastro intestinal symptoms (of which constipation is one of the most common), pains in back and limbs and occasionally an erythematous rash. A diagnosis of influenza is often made when such a patient seeks medical advice.

Certain characteristic symptoms, however, should lead to the recognition of the real nature of the illness. These are drowsiness by day, giving place at night to a muttering occupational delirium, and signs of cranial nerve involvement such as squint, diplopia, ptosis, and nystagmus, all of which may be very transient.

The nervous symptoms may be referable to involvement of any part of the nervous system including nerve roots, and they may for practical purposes be divided into irritative and paralytic symptoms. The former include wild choreiform movements with active delirium, Jacksonian convulsions,

rhythmic twitching of strands of muscle fibres occurring at random throughout the skeletal musculature and root pains of extreme severity. The paralytic symptoms are on the whole less diverse, and consist generally of the cranial nerve palsies mentioned above. Paralysis of trunk and limb musculature is rare, but hemiplegia is not unknown.

The characteristic lethargy of the malady is seen in patients in whom paralytic symptoms occur, and is commonly absent when irritative symptoms predominate. The lethargic patient lies apparently asleep but is readily aroused to answer simple questions, relapsing at once into lethargy unless his attention is continually held. At night he tends to emerge from this state, passing into the occupational delirium already mentioned.

In a given case irritative and paralytic symptoms may coexist, or the former may give place to the latter during the course of the illness.

Many of the milder cases remain ambulant throughout the illness, the occurrence of which is first recognised, sometimes months later, by the development of characteristic sequels of the disease.

It is clear that the physical signs found on examination vary greatly from case to case, but their general character will be evident from what has been said. There is no single objective physical sign which is constant, and diagnosis depends upon the careful consideration of the clinical course of the illness and upon the combinations of signs present. Thus the combination of lethargy, ptosis, squint, and diplopia, with a mild febrile reaction, is perhaps the commonest clinical expression of the disease. No very reliable information is to be obtained from the study of the reflexes, which present no characteristic changes and vary from case to case. Sensory loss is exceptional. In rare instances the malady begins with the symptoms of a brisk meningeal reaction, and the presence of acute meningitis can be excluded only by examination of the cerebrospinal fluid. It is doubtful if fresh cases of this malady have occurred in this country for some years, and cases so diagnosed not rarely prove to be tuberculous meningitis or cerebral tumour. The temptation to make the diagnosis of encephalitis because no other can easily be made is one to be resisted.

Course and Prognosis.—As we have said, the course of the disease is extremely variable. Cases in which irritative symptoms with restlessness or delirium predominate tend to last longer and to end fatally more often than those of the common type with lethargy and cranial nerve palsies. It is not possible, however, to speak of any case as mild, since profoundly disabling sequels are as apt to follow a slight and

transitory initial attack as one of greater apparent severity, and although relatively few acute crises end fatally in the initial attack, a restoration to normal health is exceptional.

Sequels—Symptoms indicating focal lesions in the brain may develop at any period after recovery from the initial illness up to three or four years, and certain clinical pictures have come to be recognised as indicating the previous occurrence of such an illness. Of these, the commonest is that of Parkinsonian rigidity. In rare instances such a condition may develop during the acute stage of the malady, but commonly it develops insidiously some months or even years after recovery from this. The patient becomes progressively slower in all his movements, his face takes on the immobility of paralysis agitans, and his gait and stance slowly come to resemble those seen in this disease. This so called post-encephalitic Parkinsonism in its early stages is most easily seen as the patient moves about and carries on his normal activities, and if it escapes the observer's eye in these circumstances is apt to be missed during a routine clinical examination. The facies is fixed and has a somewhat staring expression due to slight retraction of the lids. The gait is slow, the arms are not swung normally, and the whole body seems to be held in such a way as to cut down movement to a minimum. When the eyelids are closed they develop a fine tremor, and a similar tremor of the lips and tongue is common. Passive manipulation of the arms reveals a peculiar rigidity of variable degree. The hands have the characteristic posture seen in paralysis agitans and the tremor of this disease may be present in them. The skin of the face is often greasy, and saliva trickles from the angles of the mouth in the severer cases.

Other residual symptoms are persistent weakness of cranial nerves, third, sixth or seventh, rhythmic muscular twitchings of face or other muscles, bizarre and complicated involuntary movements of the eyes, face, tongue, trunk or limb musculature, and disorders of respiratory movements.

In children particularly, mental changes may predominate. The child becomes refractory and intractable, and shows disorders of moral conduct. In adults, mental apathy, persistent drowsiness, and undue fatigue are common.

Once these residual symptom complexes develop they tend to progress, and recovery or material improvement is exceptional.

Treatment—No drug is known to have any certain influence upon the acute stage of the disease. Favourable results are said to have followed the intravenous injection of sodium salicylate (2.5 per cent solution in normal saline, 10 c.c. daily for 8 days).

As in all infections and intoxications of the nervous system, complete rest in bed is indicated and should be maintained for at least three weeks after symptoms have disappeared. Return to normal physical activity should be delayed for at least three months.

The treatment of post-encephalitic Parkinsonism is purely symptomatic, and consists in the administration of hyoscyne hydrobromide (gr $\frac{1}{16}$ to $\frac{1}{8}$ by mouth t.i.d.) or of tincture of belladonna or of stramonium in increasing doses (up to Mxxx t.i.d.). It is said that the addition of pilocarpine nitrate (gr $\frac{1}{2}$) to each dose increases tolerance.

For the oculogyric crises a hypodermic injection of hyoscyne hydrobromide (gr $\frac{1}{16}$) may be necessary in the more distressing cases.

For the children who show conduct disorders institutional treatment may be necessary.

POST INFECTIVE ENCEPHALITIS

Rarely, a form of encephalitis may appear in association with the exanthemata, measles, smallpox, chicken pox, mumps and vaccination. It develops suddenly on or about the tenth to the fourteenth day of the illness. There is a cerebral and a spinal (myelitic) form.

The pathological lesion is strikingly uniform and consists of destruction of the myelin sheaths within brain and cord, the nerve cells being little affected. It is probable, therefore, that we are dealing not with a true virus disease of the nervous system but with an intoxication of the nervous system associated with a systemic virus infection.

Symptomatology—In the *cerebral form* there is a recrudescence of fever, the child becomes somnolent, or delirious, and may have convulsions. Clinical signs of meningitis may be prominent. Cranial nerve palsies, hemiplegia, paraplegia or involuntary movements may all occur, with incontinence of urine and faeces. Papilloedema is common. In most cases improvement begins in three or four days, and the child passes through a phase of irritability to complete recovery. Residual paralysis may be left. Some cases, however, end fatally. The *spinal form* consists of paraplegia of sudden onset with retention of urine and some sensory loss. If death does not ensue within a few days, complete recovery may be expected.

In both forms the cerebrospinal fluid contains an excess of lymphocytes, but the chemical changes of acute meningitis are absent.

HERPES ZOSTER

(Shingles)

Clinically, this malady consists in the appearance of an acute vesicular eruption within the distribution of a dorsal spinal nerve root. The pathological process is an acute infective inflammation of a spinal root ganglion, the lesion resembling that seen in the anterior horns of the spinal cord in acute poliomyelitis, though there is no reason to suppose that the virus in the two maladies is the same.

The relationship of herpes zoster to chicken-pox is discussed elsewhere (*vide* p. 48).

Ætiology.—This is believed to be a true virus infection of the posterior root ganglion cells, though full confirmation is yet lacking. If there be any difference in sex incidence, males are slightly more often affected than females. The malady may occur at any age from childhood upwards. The period of maximum incidence is said by Head to be adolescence, but very conflicting views have been expressed on this point. Some authorities maintain that it is commonest in the second half of life. When it occurs in elderly persons it is invariably a more painful affection than when the subject is young.

In the majority of cases herpes zoster arises without any discoverable cause, and in these circumstances may be regarded as an acute specific virus infection of the dorsal root ganglia, having an initial phase of febrile disturbance followed by the appearance of the specific lesion.

Confirmatory of this view of the nature of zoster is the rarity of second attacks, and the tendency to occur in small outbreaks or at certain periods.

It may occur in the subjects of pulmonary phthisis, in individuals taking arsenic, in acute myelitis and in spinal caries at the level of the lesion, and occasionally in tabes dorsalis. Herpes zoster stands in some as yet unknown relationship to chicken-pox; the appearance of herpes in a family being sometimes followed after an interval of fourteen days by a case of chicken-pox.

Morbid Anatomy.—The ganglion is swollen and hyperæmic. The vessels are congested and there are numerous minute hæmorrhages and intense lymphocytic infiltration. Chromatolytic changes are present in the ganglion cells. In cases of long standing, secondary glial reaction is the prominent feature.

The cerebrospinal fluid indicates a meningeal reaction by an increased lymphocyte and globulin content.

Symptomatology—As in acute poliomyelitis there may be an initial febrile reaction of three or four days' duration. The temperature may reach 102° F in children. There is pain from the outset at the site in which the rash is later to appear and if the mid thoracic region be affected, pleurisy may be suspected. The rash appears on the third or fourth day, at one or more of the situations in which the cutaneous branches of the affected nerve root come to the surface and spreads along the distribution of the nerve twig from this point. The rash develops for from two to six days, appearing first as an erythema upon which vesicles filled with clear fluid subsequently develop. From the fifth to the tenth day the vesicles begin to dry up and scab ultimately scarring may be left particularly if the blisters have broken and any infection of the resulting shallow ulcers has occurred. The pain lasts until the rash begins to heal and may vary from an uncomfortable itching to intense burning pain. In elderly patients however it may persist for months with great severity and prove intractable to treatment. Peculiar to elderly patients is herpes zoster in the distribution of the trigeminal nerve more especially in that of the first or ophthalmic division. Vesicles appear on the side of the nose and over the brow, and sometimes on the cornea. If the corneal ulcers which result from bursting of the vesicles become infected, severe corneal ulceration may ensue. Occasionally there is an associated iritis. Rarely ocular palsies and ptosis may be associated with trigeminal herpes just as facial palsy may occur with geniculate ganglion herpes (see also Facial Paralysis p 890). Sometimes also we see paralysis of muscles innervated from the spinal cord segment the dorsal root ganglion of which is affected. Thus herpes of the seventh and eighth thoracic ganglion may be accompanied by paralysis of the rectus and oblique muscles of the abdominal wall. All these paralyses tend to recovery.

Herpes labialis and herpes febrilis are not related to herpes zoster.

Treatment—The course of the eruption is uninfluenced by treatment. The vesicles are best dusted with a starch or zinc oxide powder or a collodion dressing may be applied over the whole affected skin area. The latter measure is the best when the situation of the eruption allows of it since it protects the burst vesicles from secondary infection and from friction and appears to have some analgesic value. Post herpetic neuralgia is difficult to relieve and on occasion it may be necessary to use morphia in aged and debilitated subjects whose sleep is impaired by pain. Before recourse is had to this however

aspirin, phenacetin and effeino citrate, or luminal or tincture of gelsemium and bromide may be tried

SYPHILIS OF THE NERVOUS SYSTEM

Hitherto syphilis has been regarded as the most important single factor in the causation of organic nervous disease but with the diminishing incidence of primary syphilis it is probable that neurosyphilis will no longer maintain its sinister position in this respect if, indeed, disseminated sclerosis is not already as common a malady as neurosyphilis in all its forms

There is still much that is uncertain in the pathology of syphilis as it affects the nervous system, but the following brief summary represents the most widely accepted body of opinion in respect of two important points in the ætiology of neurosyphilis

1 THE MODE AND PERIOD OF INVASION OF THE NERVOUS SYSTEM—In a small proportion of cases of primary syphilis at a stage when the Wassermann reaction in the blood is still negative, examination of the cerebrospinal fluid reveals signs of a meningeal reaction, namely, an increased lymphocyte and globulin content in the fluid This proportion steadily increases through the primary stage of syphilis and during the acute secondary stage approximately 50 per cent of all syphilitics present signs of a brisk meningeal reaction

This reaction is undoubtedly due to invasion of the meninges by the spirochæte, and it is now believed that such a meningeal inflammatory reaction is an essential condition of invasion of the central nervous system by spirochætes and that when such invasion occurs it is at this early stage of infection and at no other It appears, therefore, that the foundations of subsequent neurosyphilis are laid during the primary and acute secondary stages of the infection Unfortunately, in the present state of knowledge we cannot tell whether, in a given case, the meningeal reaction is accompanied by invasion of the nervous tissues since this invasion in the great majority of cases gives rise to no special symptoms at this stage

Usually, whether invasion has occurred or not, the cerebrospinal fluid returns to a normal state If invasion has not occurred it remains normal, but in other cases it later presents evidence of a fresh meningeal reaction, which responds incompletely, if at all to antisymphilitic treatment It is in such cases that the later development of neurosyphilis is to be feared

It is probable that the meninges are the sole channel of access of the spirochæte to the nervous system

2 THE LESION OF NEUROSYPHILIS.—The invasion of the central nervous system gives rise to no signs of pathological change for a period of years in most instances, and the cause of this latency has not yet been satisfactorily explained. It cannot be due to an extremely slow process of parenchymatous degeneration of nerve cells and fibres, and is more likely to be due to a delayed hypersensitiveness of a parenchyma actually invaded long since. Histological investigations of the lesions in neurosyphilis indicate that there are two main types of lesion—a so called *meningo vascular syphilis*, in which there are signs of active pathological change in vascular and supporting tissues with inconsiderable damage to the nervous elements, and a so called *central or parenchymatous syphilis* in which signs of meningo vascular lesion are inconsiderable and not active and in which degenerative changes in nerve cells and fibres predominate.

It was formerly supposed that these lesions represented two essentially distinct syphilitic processes, but it is now widely accepted that parenchymatous lesions are invariably secondary to meningo vascular changes although these may have ceased to be active long before the clinical signs of parenchymatous degeneration appear. Further, the view that the lesions of so called parenchymatous syphilis are systemic, involving certain neuronal systems and these alone has also been found to be untenable thus removing one of the strongest grounds for a belief in a pure neuronal degeneration as a special expression of neurosyphilis.

We may say therefore that in the nervous system as elsewhere in the body, the essential lesion of syphilis is an arteritis, with which is associated a perivascular lymphangitis, and a meningitis when the vessels affected lie in the meninges. The arteries show intimal thickening with perivascular infiltration of the adventitia by lymphocytes and plasma cells. Such a lesion forms the basis of gumma formation. The details of the lesion in the several varieties of neurosyphilis will be considered when these are described.

THE CEREBROSPINAL FLUID IN NEUROSYPHILIS.—Some further details on this subject are necessary.

1 *Primary and Secondary Stages*.—During the primary stage of syphilis a meningeal reaction is present in from 15 to 20 per cent of cases. The earliest change is an increase in the lymphocyte content of the fluid. As the secondary stage advances the lymphocytes increase in number, ranging from 25 to 100 or more per cubic millimetre, also some polymorpho nuclear and plasma cells may be seen. Protein excess does

not usually appear until the secondary stage is reached. A positive Wassermann reaction is exceptional, occurring in some 10 to 15 per cent of cases.

After the passing of the acute secondary stage, whether the case be treated or not, the lymphocytosis disappears or becomes considerably reduced, but a recurrent and very brisk meningeal reaction may develop, occasionally associated with clinical signs of neurosyphilis (optic neuritis, cranial, and spinal nerve lesions). A high pleocytosis may now be found in the cerebrospinal fluid, amounting to 1000 cells per cubic millimetre (lymphocytes, polynuclear, and plasma cells) together with a strongly positive protein and Wassermann reaction. This reaction is generally responsive to active antisyphilitic treatment.

2 Latent Period — The second and third years after infection. During this period about a fifth of all cases of syphilis present a lymphocytosis, protein excess, and positive Wassermann reaction in the fluid. If the fluid be normal during this period the subject is unlikely to develop neurosyphilis later, but there is no high degree of certainty on this point, as normal cerebrospinal fluids have been found at this stage in syphilitic subjects who later develop general paralysis. This is probably an exceptional state of affairs.

3 Tertiary Syphilis — Unless there is syphilitic meningitis the fluid at this period will be normal. In acute syphilitic meningitis at this stage the cerebrospinal fluid contains up to 500 lymphocytes per cubic millimetre, up to 100 mg of protein per 100 c.c., and a strongly positive Wassermann reaction. The blood Wassermann is also positive. In chronic syphilitic meningitis these changes are present, but are of less intensity than in the acute process.

In syphilitic cerebral vascular disease there will be no characteristic changes in the cerebrospinal fluid unless there be an associated meningitis. A relatively low lymphocytosis and protein increase, with or without a positive Wassermann reaction, is the rule. The blood Wassermann is positive. In cases of syphilitic hemiplegia a negative cerebrospinal fluid Wassermann may be obtained in about half the cases.

In congenital syphilis the cerebrospinal fluid shows very inconstant changes, but with juvenile tabes or general paralysis the characteristic changes in the fluid are found.

4 In Tabes Dorsalis cerebrospinal fluid changes of moderate intensity are the rule. The cell count varies from 10 to 80 lymphocytes per cubic millimetre. There is a weakly positive protein reaction and a positive Wassermann

reaction in blood or fluid, or in both. The last named reaction is negative, however, in the fluid and blood in 25 per cent of cases. When a positive fluid Wassermann is present it is rarely influenced by antisyphilitic treatment. A reduction in the cell count is more easily obtained, but is not necessarily accompanied by any improvement in the clinical condition. Further, the clinical progress of a case of tabes dorsalis is not necessarily reflected by the condition of the cerebrospinal fluid, which is, in consequence, of little value as a guide to treatment.

5 *In General Paralysis of the Insane* the pressure of the cerebrospinal fluid is raised, the cell count may range from 50 to 200 cells per cubic millimetre (lymphocytes, mononuclears, plasma cells, macrophages). The protein content is increased, and the Wassermann reaction is always positive in the fluid and almost always so in the blood. Apart from the cell count which always falls from repeated lumbar puncture alone, these abnormalities are irresponsive to treatment.

Colloidal Reactions in the Cerebrospinal Fluid—In certain nervous diseases the protein content of the cerebrospinal fluid undergoes an increase, the albumin fraction always exceeding in amount the globulin fraction of this protein. In neurosyphilis and in disseminated sclerosis, however, the globulin is relatively high and almost equals the albumin present. Associated with this relatively high globulin content, the cerebrospinal fluid develops the power of precipitating the particles of a colloidal suspension to which it is added. It has been found that colloidal gold is deceptively responsive in this way, a fact that is the basis of Lange's colloidal gold reaction, which is carried out as follows: a constant quantity of a standard suspension of colloidal gold is added to 10 graded dilutions of cerebrospinal fluid (from 1 in 10, to 1 in 10,000). In general paralysis the gold is precipitated in the first six dilutions; in tabes precipitation is maximal in the third and fourth dilutions, while in meningitic fluids precipitation is greatest in the sixth to eighth dilutions. Thus so-called "paretic," "luetie," and "meningitic" curves can be plotted.

In disseminated sclerosis the combination of a negative Wassermann reaction in the fluid with a paretic curve is found.

The practical importance of these reactions can easily be overestimated. The occasions on which they provide information not otherwise obtainable are limited. Thus it is rare indeed that a diagnosis of disseminated sclerosis really depends upon the result of this reaction and its chief value is in

differentiating certain cases of general paralysis from those of meningo-vascular, cerebral syphilis. In the former anti-syphilitic treatment leaves the reaction unchanged, but in the latter a change from a paretic to a luetic curve may occur.

CEREBROSPINAL SYPHILIS

The form of syphilis in which the lesions are predominantly meningo-vascular may involve the brain and cord separately, or both together. The morbid anatomy is the same in each case, but the clinical pictures will be described separately.

The onset of symptoms is generally first noted towards the end of the five-year period after infection, but there are sometimes clinical indications of acute syphilitic meningitis during the secondary stage of syphilis.

Morbid Anatomy.—It has been stated that the essential syphilitic lesion in the nervous system, as elsewhere in the body, is an arteritis. In the nervous system there is an associated perivascular lymphangitis. It is the vascular and supporting tissues which are thus primarily involved, the nervous elements being secondarily affected, by pressure, infiltration, or intoxication. The multiplication of the spirochæte in the perivascular lymph spaces leads to an inflammatory reaction with cellular infiltration. This may take the form of a diffuse vascular granulation tissue, or of local gummatous masses. *Gummata* generally arise either in the dura or in the pia-arachnoid, the latter being the more common situation. They form nodules of varying shape, and when they occur over the convexity of the hemisphere they are lentiform, compressing and infiltrating the subjacent brain, and sometimes giving rise to the signs of cerebral tumour. At the base of the brain they tend to form small nodules situated in a mass of thickened and inflamed pia-arachnoid and forming part of a gummatous meningitis. *Gummatous meningitis* may occur over any part of the brain, but is most frequent in the interpeduncular space, where it involves the meningeal sheaths of the cranial nerves and of the chiasma. To the naked eye the pia-arachnoid is thickened and gelatinous, and the subarachnoid space contains exudate. The vessels entering into and derived from the circle of Willis are also involved.

Syphilitic Meningo-Myelitis is the common form of spinal syphilis and is a pathological process like that already described. The lesion is generally localised to several adjacent segments of the cord, and tends to produce the signs of a focal transverse

cord lesion The pia arachnoid becomes adherent to the subjacent cord, which is infiltrated by the gummatous process with the production of a varying degree of myelitis

Involvement of the spinal dura leads to the production of *pachymeningitis cervicalis hypertrophica*, a condition of primary thickening of the dura which in the cervical region is swollen, hard, and may completely fill the vertebral canal The nerve roots are compressed and atrophy, and the cord itself undergoes some degree of constriction, and shows a varying degree of secondary sclerosis sometimes with cavitation

Symptomatology—(a) **Cerebral Syphilis**—There are two clinical types of cerebral syphilis that produced by gummatous meningitis at the base of the brain, and that due to syphilitic endarteritis of the central branches of the middle cerebral artery In both forms the development of objective physical signs is preceded by premonitory symptoms These are headache, sometimes of great severity and usually worse during the night, and mental and emotional changes of varying degree The fine edge is taken off the patient's intellectual capacity and he becomes forgetful and irritable Delirium or apathy may be present After some weeks or months of this prodromal stage, objective signs develop In the case of gummatous meningitis the signs are cranial nerve paralyses, which may be unilateral, although the pathological process is bilateral Pupillary abnormalities (myosis, inequality, and irregularity of outline, deficient or absent light reaction), squint, diplopia, ptosis, deafness, and tinnitus, facial weakness and sensory changes over the face all serve to indicate the nerves involved With meningitis on the convexity of the hemispheres, Jacksonian fits and transient hemiparesis or aphasia may be present

In syphilitic endarteritis obliterans of the central branches of the middle cerebral artery, cerebral thrombosis may result with hemiplegia The symptomatology of this condition has already been described in the chapter on cerebral vascular disease (*vide p 788*)

(b) **Spinal Syphilis**—Although the clinical pictures of spinal syphilis vary greatly and fall into several groups, the underlying pathological process is remarkably uniform, varying more in acuteness than in kind

1 **TRANSVERSE MENINGO MYELITIS**—This may be a process localised to a few segments of the cord and productive of the symptoms of a transverse lesion of the cord, a transverse myelitis Like the signs of cerebral syphilis, those of spinal syphilis are preceded by premonitory symptoms These are pain in the back, girdle, or other root pains and numbness

in the extremities. Signs of interference with the functions of the cord come on with a rapidity which varies from case to case. Where there is much arterial disease with softening of the cord, paraplegia with sensory loss and sphincter paralysis develop with great rapidity, and the picture of an almost complete transverse lesion may ensue within a few days. The abdominal reflexes are lost below the level of the lesion, which is commonly mid thoracic, there is sensory loss and spastic paresis of the legs. There may be retention of urine, or distension of the bladder with overflow. In severe cases total paraplegia with bed sores may be present.

2 **ERB'S SYPHILITIC PARAPLEGIA**—A much less acute and more slowly progressive form of meningo myelitis of the thoracic region of the cord is known by this name. There is relatively little weakness, but when the patient is standing or walking the legs become intensely spastic and the gait is spastic and shuffling. There is also little cutaneous sensory loss, but more marked loss of the sense of position and of vibration sensation. The sphincters, also, are severely impaired. The condition may be present for many years before the power of walking is lost. Root pains may be a prominent symptom.

3 **AMYOTROPHIC MENINGO MYELITIS** (spinal progressive muscular atrophy of syphilitic origin)—A form of meningo myelitis affecting the cervical region of the cord may produce a clinical picture closely resembling that of progressive muscular atrophy. The signs are atonic atrophy beginning in the small hand muscles, in the shoulder muscles, or in those of the leg. This may be unilateral or bilateral, and is often preceded by root pains. There may be spastic paresis of the legs, some impairment of vibration sense in the legs and loss of sphincter control. The Argyll Robertson pupil is present in an appreciable proportion of these cases. The blood Wassermann reaction is positive in two thirds of the cases, and the cerebrospinal fluid gives a positive reaction in all untreated cases. This condition may be present in association with *tabes dorsalis*.

4 **PACHYMEINGITIS CERVICALIS HYPERTROPHICA**—In this there are root compression symptoms—pains radiating down the arms, wasting and weakness of arm and hand muscles with alterations in the arm jerks and sensory impairment. The legs show a condition of spastic weakness.

Diagnosis—These various clinical forms of spinal syphilis may have to be differentiated from several spinal cord diseases—*infective myelitis*, *disseminated sclerosis*, *compression of the*

cord, progressive muscular atrophy. In all cases the examination of the blood and cerebrospinal fluid should be made, and other signs of syphilis sought for. Papillary abnormalities of the type described above may afford the necessary clinical confirmation. A history of syphilitic infection is of importance, though the absence of such a history is of no value.

These criteria must also govern the differential diagnosis of cerebral syphilis. It must be remembered that both cerebral tumour and syphilitic infection are common occurrences, and that the presence of a positive blood Wassermann reaction in a case of suspected cerebral tumour is not adequate reason for regarding the latter as a gumma.

Prognosis.—Recent cases of cerebral syphilis or of spinal meningo-myelitis respond well to energetic antisymphilitic treatment. Long-standing cases, on the other hand, respond less well, and even though the pathological process be arrested, some residual disability tends to remain. Erb's syphilitic paraplegia usually responds little if at all to treatment, while amyotrophic meningo-myelitis may be arrested but seldom cured in the sense of recovery.

DEMENTIA PARALYTICA

(General Paralysis of the Insane)

This is essentially a syphilitic affection. Males are affected far more frequently than females. The onset occurs from ten to twenty years after primary infection, that is, commonly between the ages of thirty to forty-five. The percentage of syphilitic subjects who develop this malady is probably extremely small. Occasionally the subjects of congenital syphilis develop the malady in childhood.

Morbid Anatomy.—The skull bones are dense, and beneath the dura there may be signs of old subdural hæmatomata (chronic hæmorrhagic pachymeningitis). The brain is shrunken and diminished in weight. The pia-arachnoid is thickened and opaque, and may be adherent to the subjacent brain. The convolutions are atrophic and the sulci correspondingly wide. The ependyma is "frosted" in appearance and is seen to be studded with tiny, closely-set granules. Microscopically, the maximal degree of change is found in the frontal lobes; the vessels are dilated and show signs of proliferation; their walls are thickened, and the perivascular spaces infiltrated with lymphocytes, plasma, and other cells. There is marked neuroglial reaction. The nerve cells reveal various stages of

chromatolytic degeneration, and the superficial nerve fibres are also degenerated. Spirochetes may be found.

Symptomatology.—There are various clinical pictures characteristic of the disease, especially in its earliest stages. In some subjects mental deterioration is the earliest symptom. In others objective neurological signs are prominent from the first, with corresponding symptoms.

Mental Symptoms—The essential feature is a slowly progressive deterioration of the intellect, the most complex and most recently acquired faculties being first and most severely hit. Judgment, memory, and receptivity begin to fail. The standard of conduct falls off, and the patient becomes careless of the conventions and may develop moral aberrations. He becomes suspicious and irritable, and impatient of any kind of restraint. He may be sullen and depressed or exalted and boastful. He uses his financial resources rashly and may ruin his family as a result. The familiar picture of grandiose ideas with absurd boastfulness is, perhaps, not the common one, and most patients are depressed and introspective. These changes develop gradually and are best noticed by the patient's immediate family circle, which suffers most severely from his aberrations. With the passing of time, memory and judgment progressively fail, and ultimately a severe grade of dementia develops.

Associated with this mental picture is the presence of objective physical signs of organic nervous disease. In the early stages these are unequal and irregular pupils which react badly to light, tremor of the lips and tongue and of the hands. Articulation is slurring. Defects in the speech function appear later. A partial primary optic atrophy is common. The reflexes show progressive alteration, the tendon jerks becoming brisker than normal and the plantar responses becoming of the extensor, or Babinski, type. Gradually bilateral spastic paresis develops, with loss of sphincter control, and ultimately the patient becomes a helpless, bedridden dement. This progress is punctuated in the early stages by transient apoplecticiform and epilepticiform seizures, the so called "congestive attacks." They are associated with transient hemiplegia or aphasia. Again acute maniacal outbursts or sudden phases of exaltation may occur. Remission of symptoms is common, the patient improving in a most remarkable fashion and retaining the improved level of mental and physical health for some months.

Occasionally the symptoms of general paralysis may be associated with certain signs of tabes dorsalis, the so called

taboparesis The clinical course of this condition, however, is much slower and longer drawn out than that of general paralysis alone

Course and Prognosis—The malady usually runs its course to a fatal issue within three or four years. More acute cases occur in which death ensues within a year. The various clinical varieties have each their characteristic course and duration.

Diagnosis—This may present difficulties in the initial stages in those cases in which objective signs are scanty. The patient has no insight into the alteration in his mental and emotional state which may not be evident unless an independent history can be obtained from his relatives. In many cases it is by information derived from a patient's wife that the presence of definite mental deterioration can alone be discovered, and the patient's story should always be compared with that obtained from some competent witness. It is in the case of the depressed hypochondriac subject that these difficulties are most in evidence and a diagnosis of neurasthenia should be made with reserve in a middle aged man of this type until general paralysis has been definitely excluded by careful clinical examination and examination of the blood and cerebrospinal fluid. The objective signs to be sought for are pupillary abnormalities, tremor of the lips and tongue, slight slurring of speech and alterations in the reflexes.

Another source of difficulty is the close resemblance which some cases of cerebral syphilis bear to general paralysis and in this case a differential diagnosis may be impossible without some period of observation and one or more examinations of the cerebrospinal fluid (*vide* p. 846).

Treatment will be dealt with later (*vide* p. 865).

TABES DORSALIS

This common malady of the nervous system is essentially syphilitic in origin. It makes its appearance from five to twenty years after infection and is much more common in men than in women. It is occasionally a result of congenital syphilis and like general paralysis may exist in husband and wife when one partner has acquired syphilis from the other.

Morbid Anatomy—On naked eye inspection, the dorsal columns of the cord are seen to be shrunken and translucent in appearance on section of the cord. The dorsal roots are also similarly shrunken and have a pinkish, gelatinous appearance. The change is most marked in the lumbar and thoracic regions.

of the cord. Other evidence of neurosyphilis may be present such as basal meningitis and meningo myelitis.

The evolution of the essential lesion in tabes is still a matter of controversy. While the signs and symptoms of the disease are a consequence of the degeneration of the exogenous fibres of the posterior columns of the cord, as these lie in the root entry zone, it is not certainly known whether this degeneration is a primary parenchymatous change or is secondary to a local meningitis of the posterior roots outside the cord. It seems probable, however, that the first explanation will prove to be the correct one.

The short and medium length fibres tend to degenerate earlier than the long fibres and, like other nerve fibre degenerations, this process does not extend beyond the synapse in which the affected fibre ends. The degeneration in tabes is therefore confined to the exogenous dorsal root fibres, and can be traced up through the dorsal columns of the cord from lumbar region to the posterior column nuclei in the medulla. The cranial nerve palsies which are sometimes seen in cases of tabes are due to a meningo vascular process such as has already been described. The primary optic atrophy of tabes is also the result of a similar process in the sheath of the optic nerve, and is not, as was formerly supposed, a primary syphilitic degeneration of the optic nerve neurones.

The pupillary changes of tabes are even more obscure in their origin than is the essential lesion of this disease. Neither the view that there is a degeneration of light reflex fibres, nor that which invokes changes in the ciliary nerves is entirely satisfactory, and the question remains an open one.

A common post mortem finding in subjects dead of tabes is a syphilitic aortitis or aneurysm.

Symptomatology—Since tabes dorsalis develops very slowly, not all its physical signs are equally early in development, and the malady may be readily recognisable at a time when some of its so called cardinal signs are absent. Further, it may be arrested at any stage of its evolution and thus continue indefinitely to present an incomplete clinical picture. Hence the old division of the clinical course into 'pre ataxic' and 'ataxic' stages is fallacious and useless. Finally, in some cases there is no noticeable disability, or subjective symptom, which is obviously nervous in origin, and the disease may be discovered only during the course of a routine examination of the patient. Since it is a disease of the primary afferent neurone its signs and symptoms must necessarily be of the

following character Pains and paræsthesiæ, sensory impairment, ataxy of movement of sensory origin, loss of tendon reflexes muscular hypotonia To these we may add impairment of sphincter control and of sexual desire and power, trophic lesions and pupillary anomalies

In its early stages the common subjective symptoms are pains The most typical of these are the "lightning pains," which are very rarely absent and which may antedate all other symptoms by a period of years Since the tabetic lesion is in the lumbar and thoracic regions of the cord, these pains are present in the lower limbs and trunk They are sharp and sudden in incidence and come in paroxysms which are more severe and frequent in wet, cold weather They rarely run up or down the length of the limb, but seem to strike into the limb from outside and are described as "stabs of pain" "like a needle being stuck into the leg" They are common in the heel, calf, and region of the foot Pains of a similar character may be present in the thoracic wall

These pains vary in severity, and when not intense may be interpreted by the patient as due to "rheumatism" or some other supposedly minor ailment, and may thus not be seriously regarded by him Various other pains and paræsthesiæ in limbs and trunk may also be complained of

On examination, the following objective sensory disturbances are usually found Over the front of the thorax, from the level of the second rib to that of the lower costal margin, where it forms a cuirass of sensory change, is an area of analgesia and sometimes of tactile and thermal anæsthesia or hypoaesthesia also This area may extend down the medial aspect of the upper limbs to the little and ring fingers The region of the perineum may also be similarly insensitive, especially in those patients in whom alteration in sphincter control is an early symptom In respect of deep structures, the tendo Achillis is almost always painless on pressure, or if painful sensibility be retained in any degree, its conduction is delayed and the patient cries out one or more seconds after pressure is put upon the tendon The ulnar nerve at the elbow may also be relatively insensitive to pressure Over the nose and upper lip in those patients with an Argyll Robertson pupillary reaction there is commonly an area of analgesia, the so called "tabetic mask" of Duchenne Examination of the limbs for the sense of position may reveal some impairment Passive movement of the great toe, the patient having his eyes shut, may be possible through an abnormally wide range before it is perceived, and in the heel knee test, carried out

under the same conditions, the error of projection of the heel may be considerable. When this form of sensory loss is marked, there will be some degree of ataxy of gait, or if not, then some Rombergism will be present. That is to say, when the patient is deprived of the use of vision the impairment of senso of position leads to some unsteadiness of stance and to swaying that does not occur when vision is employed. Rombergism is a sign of defect in the sense of position in the legs and will occur in any malady in which there is this form of sensory disturbance. It must be emphasised however, that in the early stage of progressive tabes or in arrested cases neither Rombergism nor ataxy of stance or gait may be present. In cervical tabes similar disorders of the upper limbs may be found.

The Reflexes—The afferent limb of the reflex arcs concerned in these reactions being involved, the tendon jerks in the legs slowly diminish in activity and finally disappear. The first to go are the ankle jerks, and their disappearance may precede that of the knee jerks by a considerable period. Therefore, retention of the knee jerks does not necessarily exclude the presence of recognisable tabes. The arm jerks tend to go even later than the knee jerks and may be retained for an indefinite time, except in involvement of the cervical posterior root fibres.

The Pupils—From the onset of the disease the pupils become progressively smaller, and ultimately a high degree of myosis obtains. Simultaneously they lose their circular outline and become unequal in diameter and the reaction to light wanes until it is lost. While this loss of reaction to light is perhaps the most important feature of the pupillary changes in tabes, myosis is, sooner or later, an almost invariable accompaniment of this loss and was so regarded by Argyll Robertson after whom the phenomenon is named. Reaction to accommodation is retained until the terminal stage of the malady, when it too may be lost.

The common sphincter defect is hesitancy of micturition with a tendency to dribbling incontinence after a voluntary act of micturition. Impairment and early loss of both sexual desire and power is a very common symptom at this stage of the malady but is not invariable. The cutaneous reflexes (abdominal and cremasteric) are retained and are usually very brisk throughout the malady. The plantar responses are of normal type.

We may sum up the signs and symptoms of early tabes dorsalis, or of non progressive cases of the disease, as follows

Lightning pains, objective sensory disturbances on face, trunk, and lower limbs diminution or loss of the knee and ankle jerks the presence of Rombergism or of ataxy of gait and stance in a proportion of patients, but not in all, the presence of a varying degree of abnormality in the appearance and reaction of the pupils, and some defect in sexual function and in sphincter control

In the more advanced stage of progressive cases, the physical signs mentioned above become more evident, though the characteristic pains may wane and almost cease except as occasional phenomena. The loss of sense of position in the legs leads to marked ataxy, sometimes of a degree which completely takes the patient off his feet and gives him a superficial appearance of being partially paralysed. However, bed tests of muscular power reveal that this is not impaired, although co-ordination may be grossly disordered. The arms may be similarly affected.

Sensory loss tends to involve larger areas of the trunk and limbs, although the abdominal wall retains sensibility in some patients for a long period.

All the tendon reflexes may disappear. In the terminal stages of tabes the pupils become extremely small and the reaction to accommodation is commonly lost, the pupils being immobile.

Sphincter control tends to become more defective, and incontinence of urine may be a distressing symptom. It is often accompanied by profound loss of sensation over the perineum and in the external genitals, so that the passage of urine and feces, and even of a catheter, cannot be felt. The bladder invariably contains several ounces of residual urine, and is commonly infected. The presence of chronic infection from this source is in part responsible for the pallor and cachectic appearance of most tabetics of long standing.

Among the inconstant symptoms of tabes are the following —

Ataxy—Many cases of tabes run their whole or a great part of their course without the development of this disability. Its absence indicates the integrity of those afferent fibres which subserve the sense of position and of movement. On the other hand, gross ataxy of the lower limbs may develop acutely, either spontaneously or after confinement of the patient to bed from injury or some intercurrent malady. Such an acute ataxy may first draw attention to the malady in cases which have previously been free from marked subjective symptoms of any kind. When it is severe in degree, standing

may be quite impossible owing to the complete absence of control of movement. In less severe grades the patient stands with a wide base, and as he walks keeps his gaze intent upon his feet. These are raised over high and are stamped down, heel first, with undue force. The legs are widely separated and perform many adventitious movements from the combined effects of ataxy and voluntary efforts at correction.

Visceral Crises—Of these the commonest is the gastric crisis, which in its complete form consists of an attack of acute abdominal pain with vomiting lasting for from two or three to seven or more days. The vomiting may be severe and provoked by food. Hypersensitiveness of the skin over the epigastrium is a common accompaniment of gastric crises and may be present in the subject at other times. In some instances, vomiting may occur without pain. Tabetic patients with gastric crises are frequently subjected to laparotomy on an erroneous diagnosis of some acute local lesion when a routine examination of the nervous system has not been made, an occurrence which is rendered the more easy as the patient may, spontaneously, make no other complaint than one of pain and vomiting. It may be admitted however, that the recognition of renal colic or of a ruptured gastric ulcer may be a matter of extreme difficulty in a tabetic, in whom not less than in others these conditions may be found.

Less frequent are laryngeal crises, attacks of stridor and dyspnoea occurring at short intervals over a period of one or more hours. Abductor paralysis of the vocal cords may follow a laryngeal crisis as a temporary state or may be a permanent condition apart from crises. Attacks of tenesmus (rectal crises) or of painful micturition (vesical crises) are also known.

Although the subject may be very distressed during the period of a crisis a fatal termination does not occur.

Optic Atrophy—In an appreciable number of tabetics, optic atrophy develops and leads to progressive failure of vision, and generally to blindness, with the ophthalmoscopic appearance of a primary atrophy of the disc. The two eyes are generally affected, but not simultaneously. It was formerly held that the presence of optic atrophy led to an arrest of the tabetic process in the so called "pre ataxic stage," but a more correct way of expressing the rarity of advanced tabes in the subjects of optic atrophy is to say that in those cases in which the two lesions coexist the optic nerve bears the brunt of the disease. Tabetic optic atrophy is invariably accompanied by the Argyll Robertson pupil and

generally by loss of both knee and ankle jerks, and by the cutaneous sensory changes described above

Trophic Lesions—These may involve the skin and subcutaneous tissues, or joint and bones. The perforating ulcer on the ball of the foot is the familiar example of the former. It usually arises under a pre-existent callosity. This becomes separated from the deeper tissues, a blister or hæmorrhage occurs, the deep tissues become infected, and the callosity sloughs out, leaving a septic ulcer which does not heal.

It not infrequently happens that the patients in whom this occurs seek medical advice for this lesion, and not on account of any other tabetic symptoms. The malady tends to run a peculiarly latent course in those cases where this superficial lesion occurs, and is often non-progressive. The osteoarthropathy of Charcot (Charcot's joint) is the other familiar trophic lesion. The change is generally precipitated by some injury or strain on the joint. A rapid, painless effusion into the joint cavity follows and then bony changes begin. These may consist of rarefaction, or of rarefaction accompanied by irregular new bone formation. Destruction of the joint surfaces follows. The joint soon becomes abnormally mobile and a condition of flail joint ensues when the knee is involved. Other joints affected are the ankle, hip, wrist, and elbow. In syringomyelia a similar condition is not uncommon, the upper limb joints being the usual seat of the lesion in this case. The lumbar spine is sometimes affected. Rarefaction of long bones may lead to spontaneous fracture. As with perforating ulcers, the case may in other respects run a latent non-progressive course.

Ocular Palsies and Amyotrophy of the upper limb muscles may occur in tabes from associated syphilitic meningitis. Ptosis, squint and diplopia especially the first named are the common cranial nerve palsies. The ptosis together with the myosis gives the patient a characteristically sleepy appearance.

Visceral syphilis may also be present in the subjects of tabes syphilitic aortitis and aortic aneurysm being the commonest lesions. General paralysis or spinal meningo-myelitis may also complicate tabes.

Juvenile tabes in congenital syphilitics is comparatively rare, and when it occurs is associated with optic atrophy more frequently than is the tabes of acquired syphilis. The familiar stigmata of congenital syphilis may be absent from the subject of juvenile tabes.

Diagnosis—Although tabes is a common malady, and one readily detected by even the most rapid routine examination of the nervous system, there are few nervous diseases in which diagnosis is so often unwarrantably delayed or so frequently missed. Among the reasons for this is the fact that observers expect to find the sum total of physical signs at every stage of the malady, and some of these being absent—as they invariably are in the initial period of its development—they either fail to identify the disease or shrink from the responsibility of diagnosis upon incomplete evidence. Another important factor is the extremely variable subjective early symptomatology of tabes. Thus the patient may seek medical advice for attacks of abdominal pain and vomiting, for failure of vision for diplopia, for pains in the legs for joint lesions, or for bladder disturbances. Exclusive attention to the local symptom leads to a neglect to examine the nervous system and to a failure to recognise the presence of tabes. Moreover, it is a common experience that the subject of lightning pains, having decided that he has rheumatism in his legs, answers the question as to the presence of pain by a negative.

Early diagnosis rests upon the presence of lightning pains, the sensory changes described above, diminished or absent ankle jerks—the knee jerks being possibly normal—pupillary abnormalities, loss of pain sense in the tendo Achillis, and loss of testicular sensation. A history of syphilitic infection and the presence of any one of the above signs should lead to a suspicion of tabes and to an investigation of the blood and cerebrospinal fluid. The changes in the latter are described elsewhere (see p. 846).

Among the other diseases from which tabes has to be differentiated is multiple peripheral neuritis. In this malady the muscles are usually tender to pressure, there are no pupillary anomalies, no sphincter defects, while there is motor weakness with wasting. The history also affords important points of distinction. The presence of signs of lateral column sclerosis, of a familial history, and the age of the subject should render the differentiation of Friedreich's ataxy simple. Subacute combined degeneration of the spinal cord is also a malady in which the tendon jerks may be lost and the gait ataxic, but no error of diagnosis should arise for in this disease the leg muscles are commonly tender to pressure, there is muscular weakness, usually an extensor plantar response, and all the signs and symptoms of pernicious anæmia. There is no loss of sphincter control in this disease, except possibly in its terminal stages.

Course and Prognosis—The course of the malady is extremely variable from case to case. In some, acute ataxy brings it first under notice, while in others the subjective symptomatology and the disability remain trifling for an indefinite number of years until the patient succumbs to some other malady. Arrest may take place at any stage, and this even in cases where both blood and cerebrospinal fluid changes would seem to foretell a rapid progress of the malady. Perhaps approximately 50 per cent of all cases of tabes undergo arrest at some period short of profound disability. Nor is an early onset of acute ataxy necessarily of bad ultimate prognosis, since with suitable re-education exercises co-ordination may be restored and remain normal for a period of years. It is probable that the shorter the interval between syphilitic infection and the development of tabes, the more progressive and disabling the latter will be. The development of optic atrophy almost always means that the subject will become blind within five years.

This extreme variability of progress and the frequency of arrest should lead to considerable caution in assessing the value of treatment in any given case, and much sanguine opinion in favour of this or that remedy is based upon disregard of the natural variability of the disease.

TREATMENT OF NEUROSYPHILIS

The course of treatment necessary for a given case of neurosyphilis cannot always be decided upon those general grounds which determine the treatment of syphilis elsewhere in the body even though the essential lesion be admittedly the same in each case. Two special considerations govern the position of neurosyphilis in this respect. In the first place, mercury probably still remains the most potent available antisypilitic remedy for syphilis of the nervous system and may safely be administered when the use of the salvarsan compounds is unsafe. Secondly, from the irreparable nature of lesions of the parenchymatous elements of the nervous system when they have progressed beyond a certain point residual symptoms tend to persist long after the causative syphilitic process has finally burnt itself out. The presence of organic symptoms does not, therefore, necessarily mean that active syphilis is present. It may also be pointed out that the Wassermann reaction does not distinguish between a reaction of the organism to active syphilis and the results of

such reaction to a syphilitic process long since dead. For these reasons clinical criteria must often take precedence over serological ones in deciding on the treatment of a given case. Too exclusive preoccupation with the latter not infrequently leads to a course of repeated blood and cerebrospinal fluid examinations and to a rigour of treatment that are unnecessary and futile, and serve but to engender in the patient a syphilophobia that is far more distressing a malady than syphilis. Therefore, bearing in mind that there is no certain cure of syphilis, treatment must steer a reasonable course between an excess that may make the patient's life wretched and the other extreme of turning the patient finally adrift without counsel after a single course of treatment.

Cerebrospinal Syphilis—On the development of signs of meningo vascular lesions active antisymphilitic measures are indicated. Mercury and potassium iodide are the drugs with which treatment is begun, and after a week or two of these a course of injections of one of the salvarsan compounds may be given. In very acute cases of cerebral syphilis it is definitely dangerous to use the latter until the patient is under the influence of mercury and iodide, and the neglect of this precaution may lead to an intense exacerbation of the syphilitic process with serious results.

The method of choice in the administration of mercury is inunction. The patient is instructed to use a drachm of mercury ointment, or of oleate of mercury, daily and to rub it in with the palm of his hand for from fifteen to twenty minutes. The limb flexures are avoided, and a different place is chosen daily. A sulphur bath once a week and the use of a mouth wash containing aluminium aceto tartrate (2 per cent solution) are desirable. A total of from fifty to sixty inunctions may be given in this way, and if the patient be unable to inunct himself, a nurse using a rubber glove may do it for him. When for any reason inunction is impracticable, mercurial injections (gr 1 of mercury in sterile emulsion) into the muscles should be given weekly. Potassium iodide is given in 20 gr doses three times daily. Neosalvarsan may be given in weekly intravenous injections, beginning with 0.3 or 0.45 grm and working up, if the drug be well tolerated, to a sixth dose of 0.6 grm.

The repetition of this combined course of treatment will depend upon both clinical and serological criteria, but repetition at least once a year for several years will probably be necessary. For further details of the treatment of syphilis with arsenical and bismuth compounds the reader is referred to p 161.

Tabes Dorsalis.—Although the contrary is widely believed and stated, there is no convincing evidence that antisyphilitic remedies exert any influence upon the course of tabes dorsalis. In many instances the malady advances ruthlessly despite prolonged and intensive treatment on these lines, while in many others it becomes arrested in the absence of such treatment.

But if it be deemed expedient to give remedies of this order, mercury and potassium iodide probably are the drugs of choice, and in this case the duration and repetition of courses of treatment are better dictated by clinical than by serological standards. The persistence of lightning pains may be taken as an indication of an active tabes.

Special symptoms which call for treatment are :—

(a) *Ataxy.*—The most striking results are obtained in very many cases by re-educative exercises. In severe ataxia these may be begun in bed, the patient carrying out simple graded movements on the lines described by Fraepkel. Later, carefully graded walking exercises are given on a floor or strip of canvas on which lines or footprints are painted. These exercises demand the full attention of the patient, and at the beginning some skilled instruction. The improvement sometimes reaches restoration of normal co-ordination, which may be maintained for a period of years. In this connection may be mentioned the great importance of keeping tabetics on their feet and the danger of confining them to bed unless it be imperative. Many a tabetic has entered an institution for treatment, and after two or three weeks in bed, finds on arising that he has become profoundly ataxic.

(b) *Pain.*—The lightning pains may be controlled or relieved in most instances by aspirin, phenacetin, tincture of gelsemium, and other analgesic drugs. Morphia is strongly contraindicated unless its use is imperative as a temporary measure.

(c) *Gastric Crises.*—These are often very resistant to palliative treatment. Tincture of iodine in 2-minim doses in water, dilute hydrocyanic acid 5 minims in 2 drachms of water, or chloretone (three or four 10-gr. doses, at six or eight hourly intervals) may give relief. Here also morphia should be avoided, if possible, on account of the liability to addiction.

(d) *Disturbances of Micturition.*—Since there is commonly residual urine in all cases presenting these symptoms, infection is a complication which arises sooner or later in most cases, and may require the usual treatment of cystitis. Urinary disinfectants and bladder irrigation may be necessary. The

essence of cystitis undoubtedly aggravates the pains and her disabilities of tabes, and much relief may be obtained by careful attention to the condition of the bladder in this respect.

The avoidance of alcohol and of excess in food or tobacco is important, and if observed may serve to relieve many of the symptoms mentioned above. A regular action of both bowel and bladder is important. The patient should be urged to take exercise within the limits of fatigue when possible. The presence of perforating ulcer or of joint lesions calls for the rest of the affected part and in the latter case splinting may be necessary. The majority of tabetic patients are thin and cachectic and their adequate nourishment calls for attention.

General Paralysis—It is probable that, like tabes, this malady is wholly uninfluenced by any form of antisypilitic treatment, but since cerebral syphilis may at times closely resemble it, this mode of treatment should be adopted if there is the least doubt as to diagnosis. However, once a diagnosis of general paralysis is satisfactorily established it is wisest to consider what is so far the most efficacious non specific mode of treatment yet available, namely pyrexial therapy. This may be achieved either by infecting the patient with benign malarial infection and allowing him to have up to twelve rigors before exhibiting quinine, or by placing him in an apparatus in which he is electrically heated until a temperature of 104° and upwards is reached, and maintained for the requisite period on a number of occasions. Both these methods are not free from danger and should be undertaken only by those skilled in their use and under ideal conditions. It is not therefore necessary to describe either method in detail here, being that general paralysis when untreated is always a fatal malady the risks involved in these procedures are well justified in early cases where no marked physical disability or profound dementia is present. Following recovery from the immediate effects of pyrexial therapy, a course of trypanosome injections is begun.

It is probable that the treatment acts by the destruction of spirochaetes by the pyrexia. Parenchymatous changes in the brain cannot, of course, be remedied by this means, and the method is most valuable in early cases.

Remarkable and long standing remissions sometimes follow malarial infection, but a genuine restoration to normal is rare, and usually a mild degree of fatuity characterises the patients so treated.

It is generally advisable to conduct the treatment in an institution where any exacerbation of mental disorder can be dealt with adequately

EPILEPSY

Epilepsy is a chronic malady characterised by the recurrence of sudden brief disturbances of cerebral function, of which the essential feature is a partial or complete loss of consciousness. To this in many instances may be added convulsive movements of varying severity and extent. Momentary attacks with minimal or no convulsive phenomena are spoken of as *petit mal* or minor epilepsy, and more severe attacks with generalised convulsions as *grand mal* or major epilepsy.

Ætiology—Nothing is known of the causation of epilepsy, nor of the essential pathological process in the brain underlying the production of the fits. The fit has no known morbid anatomy, and no constant abnormality of metabolism or of endocrine function has been found in association with it. On the cerebral process which accompanies the fit some light has recently been thrown by the study of the action currents (Berger rhythm cortical potentials) produced by the nerve cells of the cerebral cortex. By the use of electrodes attached to the scalp and a suitable amplifier these potentials can be recorded as a wave-like record on paper somewhat in the manner that the electro cardiograph records the electrical variations in heart muscle. The pattern of the waves is altered by cerebral activity and the rhythm is best seen when the subject sits at ease with his eyes closed. In this way the normal range of variations in the record have been established. It is found that during the course of an epileptic seizure and in epileptic subjects even when no clinically visible fit is present the pattern is changed in one of three ways. In major fits a fast high voltage rhythm is seen in minor fits an alternation of high slow waves and spike like waves while in the rarer psychomotor fits another characteristic wave pattern is seen.

While the study of the electro encephalogram (E.E.G.) as the record is called may provide confirmatory or excluding evidence of value in doubtful cases of epilepsy, it should be remembered that the records call for skilled interpretation and that wave patterns like those of epilepsy are to be found in some 10 per cent of the population that is in many persons who are not subject to epilepsy, epileptics forming but 0.5 per cent of the population. A diagnosis of epilepsy cannot be made on the E.E.G. alone in the absence of

clinical evidence. Even greater reserve should be observed, at present, in accepting electro encephalographic evidence as to the presence or localisation of an intracranial new growth (see p 766).

As to the significance of these electro encephalographic findings in the case of epilepsy, we can say no more at present than that they accompany fits. That they stand in a causal relation to them is not yet established.

Since fits clinically indistinguishable from those of epilepsy, as we have defined it above, may occur as symptoms in other maladies, it has been suggested that epilepsy is not a distinct disease but a group of allied symptom complexes expressive of diverse pathological processes to which the term "the epilepsies" might more accurately be applied.

Nevertheless, no malady has a more striking and clear cut clinical individuality, and even though its causation be obscure, few are better entitled to rank as distinct diseases.

Direct inheritance of the disease, though commonly believed to be frequent, is in fact exceptional. If anything be inherited it is no more than a cortical instability that may during life issue in fits, either for no discoverable cause, as in idiopathic epilepsy, or in the presence of such adventitious factors as new growth, inflammation, degeneration, or injury of the brain. A neuropathic inheritance is also thought to be common, and the occurrence of migraine, alcoholism, insanity, and so on in the ascendants is often cited, but these are vague considerations, and there is no conclusive evidence of a true inheritance of epilepsy obeying any known laws of inheritance. Syphilis plays no part in its production. The first and second decades of life, especially the latter, are those in which it most frequently begins. Its onset after the third decade is relatively uncommon, and fits beginning later than this should give rise to the suspicion of focal disease. In an epileptic subject fits may be precipitated by various factors such as anxiety, fatigue, gastro intestinal disturbances, and unhygienic conditions of life.

Symptomatology.—In the case of a major fit the course of events is relatively constant. A momentary subjective sensory disturbance (the aura) may warn the subject of the impending fit. He then falls unconscious, sometimes with a cry. The skeletal musculature at once goes into strong tonic spasm, and when this is unequal on the two sides the eyes and then the head deviate to one side. Sometimes the trunk follows, and occasionally the patient rolls over on to his face, and may thus run the risk of suffocation if he be in bed. The

arms are commonly flexed the legs extended. In a varying number of seconds the tonic spasm begins to intermit, the intermissions rapidly increasing in degree and duration so that the spasm now becomes clonic in character. The limbs now are the seat of powerful jerking movements. The tongue may be bitten either in the tonic or the clonic stage. Froth is expelled from the mouth with each expiratory jerk and is blood stained if the tongue or cheek has been bitten. Cramps due to respiratory spasm passes off with the resumption of thoracic movement. Evacuation of bladder or rectum may occur. Following the spasm the patient relaxes into a state of flaccid coma from which after some few minutes he awakes only to fall into a deep sleep in many instances. Early in the fit the pupils dilate and remain dilated and the tendon jerks are lost until consciousness is restored. During this time also the plantar responses are found to be of the extensor type. The pulse increases in force and frequency during the period of spasm becoming transiently feeble as the fit terminates. Headache and sickness may follow the fit.

The *Aura* or warning which precedes the fit is present in about three fifths of all cases of epilepsy and even when it is not entirely sensory in character has a sensory component. The sensory aura may consist of a vague visceral sensation commonly localised in the epigastrium the so called epigastric aura or of unilateral or bilateral paresthesia referred to the limbs trunk or head or of a special sense disturbance visual auditory or olfactory or finally, it may be psychical in character such as a passing idea or emotion. Motor phenomena may accompany sensory auras such as the movement of a limb a rotation of the head and eyes jerking or starting movements. They are invariably very brief in duration and are followed instantly by loss of consciousness. Unilateral and localised warnings sensory or sensory and motor combined and special sense warnings (light smell or taste) are of importance as indicating the focus in which the discharge is beginning and are particularly common in the case of fits arising from local lesions such as tumours.

Sometimes warnings occur which are not followed by fits in the subjects of epilepsy.

The nature and sequence of the convulsive phenomena have already been described. The coma which ensues after cessation of the convulsion may be transitory and rapidly recovered from or may be prolonged and gradually pass off. In status epilepticus when fits follow in rapid succession

convulsion may succeed convulsion without any intervening return of consciousness

On regaining consciousness the patient is unaware of what has happened except from the circumstances in which he may find himself. Thus the subject of exclusively nocturnal fits may know of the occurrence of a fit during the night only by the fact that he has been incontinent and that the bed clothes are disordered.

There is frequently an abundant secretion of urine after a fit and a trace of albumin or sugar may be present. Occasionally a slight rise of temperature may follow a fit and in the case of status epilepticus hyperpyrexia may develop.

In the case of a minor fit the whole attack may consist in nothing more than a momentary blunting of consciousness which is spoken of by the patient and his friends as a dizzy turn, a faint or a sensation. Those gazing at the subject when this occurs note a transient vacancy of expression, a little deviation of the eyes, possibly a slight movement of the lips or eyelids or of the head. A transient flush or pallor may pass over the face. The patient ceases whatever he may be doing at the moment of onset, stops talking or moving or drops something he happens to be holding in his hand. The attack passed off he resumes his conversation where he left off. In more severe minor attacks consciousness may be completely lost for a moment and the patient falls down only to pick himself up immediately. A definite slight convulsive movement of the face or of one or both arms may occur. When sitting at table the patient's head may suddenly drop forwards on to the table only to be raised again instantly.

Even in the absence of any trace of convulsion some subjects of minor epilepsy pass urine involuntarily in their fits.

The frequency of fits varies greatly from case to case. In minor epilepsy numerous daily attacks may occur or on the other hand intervals of days or even weeks may separate the fits. In the case of major fits also almost daily attacks or fits separated by periods of months may be the rule. In some epileptics major attacks occur only during sleep or at some other special time as just after waking in the morning. Fits of both types are frequently present in the same subject, the appearance of major attacks being preceded for some years by minor fits. In women the menstrual period is often accompanied by a special incidence of attacks.

Other phenomena found in association with epilepsy are post epileptic automatism, post epileptic hysteria and mental deterioration.

In post-epileptic automatism the subject immediately after the cessation of the attack most commonly a minor fit carries out some complicated act such as removing some particular article of clothing undressing wandering from the house or becoming violent. In a given subject the form of the automatism tends to be constant and when he finally comes to normal consciousness he is completely unaware of what has passed. Since such behaviour may follow a momentary and unnoticed minor fit various social and legal complications may arise when the automatic behaviour assumes certain forms.

Again a hysterical fit or some emotional manifestation may follow a minor or major attack and give rise to a diagnosis of hysteria in the subject of epilepsy. In all such cases a careful inquiry into the history and into the period immediately preceding the alleged hysterical phenomena may reveal the real nature of the situation.

Mental deterioration sometimes develops in the subjects of repeated fits of either type. This is the greater when fits are numerous and the malady of long standing for example in subjects who have been affected since childhood and particularly in the case of minor attacks of great frequency. In these circumstances the epileptic child may become intractable spiteful untruthful and quarrelsome. After many years of major attacks a slowly progressive dementia may set in. It must be remembered, however that these changes are not constant even in severe cases of the disease.

idiopathic epilepsy may occur as symptoms of a variety of pathological conditions intracranial tumour, general paralysis, intracranial hemorrhage and thrombosis, cardiac and renal disease

It is especially when fits make their first appearance after the age of thirty years that evidence of one or other of these conditions should be sought for before a diagnosis of epilepsy is made. In all but one of them, such evidence may be found, but as has been emphasised on p. 777, generalised fits may be the first indication of the growth of an intracranial tumour. Attacks of transient unconsciousness due to heart block (Stokes Adams syndrome, *vide* p. 509) may sometimes be mistaken for epilepsy. If the patient be seen in an attack the extreme bradycardia will settle the diagnosis.

In differentiating an epileptic from an hysterical fit it must be remembered that there is a constant sequence of events in the former, but that in the latter every patient is a law unto herself. The convulsive movements of epilepsy are clonic jerking movements, those of hysteria are complex disorderly movements of infinite variety, which tend to increase in force and extravagance if the patient be restrained. Hysterical fits do not occur during sleep in dangerous situations, nor except in the presence of an audience. The reflexes, pupillary, corneal, and tendon are all retained during an hysterical fit, and tongue biting and incontinence do not occur.

Treatment—The maintenance of a high level of general health and of a healthy régime of life are essential. Pressure of work or, in the case of children, of education, and stress of any kind are unfavourable, and tend to nullify the effects of drug treatment.

Many epileptics are ravenous eaters, and the taking of a plain diet in reasonable quantity at regular times is essential. In the case of children, good results are claimed for a diet so devised as to produce a degree of ketosis, that is one restricted in carbohydrates and liberal in fats. A daily regular action of the bowels is of importance, and if there be difficulty in this respect it is best to remedy it as far as possible by diet rather than by the habitual use of aperients. These, however may be essential. An open air life is best when practicable. Alcohol is contraindicated.

The general statement may be made that minor epilepsy is more difficult to control than major. In cases that respond well to moderate doses of bromide, that are not of long standing and in which the fits are relatively infrequent, freedom from fits is often obtained.

Whatever drug or combination of drugs be adopted in any given case the essential condition of success is continuity of treatment. No drug has an influence for more than a few hours after administration and the intermittent administration of drugs or their omission on the specious plea that they impair the intellectual energy of the patient as soon as freedom from fits for a few weeks or months has been achieved are absolutely unjustifiable. The sudden cessation of repeated fits is sometimes followed by a period of depression which is apt to be attributed to the drug used. When depression can reasonably be ascribed to this cause the proper remedy is not the abandonment of treatment but a change of the drug. The successful treatment of any given case is a matter of trial and error and many changes may be necessary before the best possible results are obtained.

Of the various drugs of value the most useful are the bromides of sodium or potassium. The dose used and the time of administration vary with each case. In nocturnal epilepsy a single daily dose of from 10 to 30 gr may be given at bed time. In other cases two or three daily doses may be given. The addition of liquor arsenicalis (℞iiij) to each dose of bromide will lessen the liability to bromide eruption. Another valuable adjuvant is tincture of belladonna (℞x). It is well borne by children and sometimes the dose may be increased to ℞xv with excellent results. Tincture of digitalis (℞v to each dose) has also been used in combination with bromide.

Borax and potassium borotartrate (gr x to the dose) have also been advocated in cases where bromide is ill tolerated but their use has not given very striking results.

Of recent years luminal (phenyl barbitone) has been extensively used. It is probably always wise to begin a course of treatment with bromide and not to have recourse to more potent substances unless this proves inadequate or unsuitable. Luminal may usefully be combined with moderate doses of bromide and belladonna. In this way smaller doses of each may be used than would otherwise be possible. Not more than half a grain of luminal should be given in a single dose until the patient's tolerance is ascertained. The common signs of intolerance are dizziness, drowsiness and the appearance of erythematous rashes. Recently a substance known as sodium diphenyl hydantoinate (Epanutin Solantom) has been introduced and in some cases it has proved more effective than the remedies already available. The dose is 15 gr three or four times daily for an adult and half that dose for a child. When used to replace phenyl barbitone the change over should be

made gradually over a period of two weeks. No final judgment is yet possible as to the usefulness of Epimutin and at present it is best used in those cases which have not responded satisfactorily to better known remedies. In a few patients toxic symptoms follow its administration. These include nausea, tremor, dizziness and even diplopia while in severe cases of intolerance a purpuric dermatitis may ensue.

When fits are known to occur at certain special periods as before menstruation the use of an aperient and an increase of the dose of drug used may fend off attacks.

During the course of a major fit the handle of a spoon or tooth brush introduced between the teeth may prevent tongue biting. The patient is best kept flat on his back with collar loosened. To arrest the course of status epilepticus hyoscine hydrobromide (gr. $\frac{1}{100}$ to $\frac{1}{50}$) or morphine (gr. $\frac{1}{4}$ to 1) may be given hypodermically or paraldehyde (3iv) per rectum.

In an ordinary case of epilepsy it is never safe to discontinue the use of drugs until there has been no fit for three years although after the second year the dosage may be progressively diminished. It is sometimes taught that epilepsy is largely if not wholly a psychogenic disturbance most rationally and effectively treated by psychological means. This view is speculative and unsound and while psychotherapy may be of value in remedying any maladaptation to his environment which the patient may show it can never be more than an adjuvant to continuous drug medication.

PYKNOLEPSY AND NARCOLEPSY

Pyknolepsy—This name has been given to a condition occurring in children between the ages of four and twelve in which slight attacks indistinguishable from those of minor epilepsy occur with extreme frequency (up to 50 daily). No mental deterioration ensues and the attacks cease spontaneously and finally at about the age of puberty. A confident diagnosis of pyknolepsy cannot be made until this natural cure has occurred an indication of the uncertain basis upon which this supposed clinical entity rests. It does not respond to any treatment.

Narcolepsy—A rare condition in which the patient is periodically overcome by an irresistible desire for sleep. He can be aroused but if left undisturbed may slumber for as long as half an hour awaking to normal consciousness. Such accesses of somnolence may occur several times daily.

Associated with these is a phenomenon of another order. Whenever the patient feels the impulse either to laughter or to anger, a sudden weakness overcomes him and he sinks helpless to the ground, retaining full consciousness and recovering in a few seconds. This is known as cataplexy.

The causation of the condition is unknown, and the patient is otherwise healthy.

A few cases of narcolepsy are found to respond favourably to ephedrine sulphate in $\frac{1}{2}$ gr doses twice or thrice daily, but really remarkable results have been obtained by the administration of benzedrine sulphate (benzylmethylecathinamine sulphate) in doses of from 10 to 30 mg twice daily, preferably on rising and at midday. The larger dose should be used with caution, symptoms of overdosage being excitability, dilated pupils and inability to relax.

MIGRAINE (PAROXYSMAL HEADACHE)

A paroxysmal nervous disturbance of which the most constant feature is headache. This may be the sole feature but in the fully developed attack visual and other sensory phenomena may be present, and also nausea with or without vomiting. This association of gastric symptoms leads to the names sick headache and 'hidious headache' by which the affection is widely known.

Ætiology—The affection commonly begins in childhood or adolescence and the subject remains liable to attacks until past middle age. Females are more frequently affected than males. Direct inheritance can be traced in most cases and evidence of a neuropathic heredity is not uncommon. Of predisposing factors errors of refraction are regarded by some as of primary importance but they are not constantly present and when present their correction does not invariably give relief. Other factors of this order are fatigue, worry, and gastro intestinal disturbances.

Symptomatology—On the day preceding an attack the patient may suffer from a vague malaise which warns him to expect it. When, as is frequently the case, the attack consists of headache alone, the subject awakes in the morning with unilateral headache, commonly temporal. This waxes in intensity and becomes severe being aggravated by movement, strong light and noise. It is least intense in the recumbent posture. It is boring and throbbing in character and may become bilateral when at its maximum. There is seldom any

superficial tenderness but eye movements especially lateral deviation or pressure on the globes may be slightly painful. Nausea frequently follows the onset of the headache. If the subject is able to keep completely at rest the headache may pass off in an hour or two but otherwise it usually persists all day.

In a fully developed attack other and more striking symptoms are added to these and the characteristic sequence of events is as follows. The patient is suddenly conscious of a bright illuminated and shimmering spot on one side of the field of vision. This tends to enlarge and to open out into a curved zigzag figure the so called fortification spectrum. This figure flickers before him and may be accompanied by a blotting out of part of the field of vision which sometimes amounts to a hemianopia. Occasionally the visual defect exists without the figure. Accompanying these phenomena a tingling sensation appears in one hand and passes up the arm sometimes appearing in the lips and tongue. In some cases a transient disturbance of speech of true aphasic character may occur. This group of symptoms endures for from ten to twenty minutes then ceases and is at once replaced by unilateral headache of the type already described by nausea and frequently by vomiting. The vomiting may herald the end of the attack which may be followed by a copious secretion of urine.

Sometimes the sensory phenomena of migraine occur without being followed by headache.

The paroxysms occur at varying intervals from once or twice a week in severe cases to attacks every few months.

Diagnosis—The definite paroxysmal course the sensory accompaniments the unilateral character of the headache and the absence of objective signs of disease serve to differentiate migraine from other forms of headache.

In those cases with marked sensory symptoms a diagnosis of minor epilepsy is sometimes made. In minor epilepsy with visual and other forms of sensory aura the duration of the aura is momentary lasting a few seconds. In migraine the sensory symptoms last for as long as twenty minutes and are immediately followed by the characteristic headache and nausea. In epilepsy also a definite fortification spectrum is not present.

Treatment—The avoidance of precipitating factors must be attempted. Be these fatigue dietary indiscretion or any local disturbance of health. Any error of refraction that may be present should be corrected. Drug treatment consists in the

continued administration of drugs to prevent the occurrence of attacks and the relief of the attack when it has appeared. For the former purpose the continuous use of bromide with nitro glycerine is generally of definite value, and the following prescription has the sanction of long and successful use. Sodii bromid, gr λ , liq trinitrin, \mathcal{M} i liq strych, \mathcal{M} iv, acid hydrobrom dil. $\mathcal{M}\lambda$, tr gelsem, \mathcal{M} x (aquam, ad $\tilde{\mathfrak{z}}\frac{1}{2}$), t.d.s. Ergotamine tartrate may avert an impending or cut short a developing attack. It may be given hypodermically (0.5 c.c. of a 0.5 per cent solution) or by mouth (gr $\frac{1}{2}$ to $\frac{1}{4}$). Luminal in small (gr $\frac{1}{4}$ to $\frac{1}{2}$ t.i.d.) doses has also been recommended. When the attack has developed rest in the dark, and the administration of such a powder as the following may be of use. aspirin gr v, phenacetin, gr v, caffeine, gr i. Occasionally alcohol or even food may have a beneficial effect in cutting an attack short.

AFFLECTIONS OF THE CRANIAL NERVES

Lesions of the cranial nerves or of their immediate central connections occur in association with various more extensive diseases of the nervous system. In this chapter we shall deal briefly with the signs of involvement of the different cranial nerves and also with certain symptom complexes wholly or in large degree expressed by disordered function of these nerves.

THE OLFACTORY NERVE

This nerve subserves the sense of smell which includes the appreciation of both odours and flavours. The true gustatory apparatus deals only with sensations of sweetness sourness and bitterness which make up but a part of the full range of what is commonly regarded as "taste". It is frequently by his diminished appreciation of the savour of his food that the subject of anosmia becomes aware of his disability. Lesions of the cerebral olfactory centres in the temporo sphenoidal lobe do not produce anosmia, but subjective sensations of "smell" may be a feature of Jacksonian fits arising here.

Bilateral anosmia may arise from local disease in the nose and its presence, therefore, has not necessarily any value in neurological diagnosis. Both bilateral and unilateral anosmia may result from the pressure of frontal lobe tumours upon the olfactory bulbs, while anosmia is a common, and sometimes the only permanent objective sign of fracture of the base of

the skull, an injury in which the olfactory filaments may be torn from the bulb

THE OPTIC NERVE

Anatomy.—After leaving the orbit the optic nerve meets its fellow at the optic chiasma, where a partial decussation takes place. The fibres from the nasal halves of the retina decussate, but those from the temporal halves enter the optic tract of the same side uncrossed. The optic tracts pass backwards from the optic chiasma round the mid brain and each contains fibres from the temporal half of the homolateral retina and from the nasal half of the other retina. Owing to this semi decussation lesions of the chiasma abolish the functions of the nasal half of each retina and thus produce bitemporal hemianopia. Lesions of one optic tract, on the other hand, produce homonymous hemianopia—blindness of the nasal field on the side of the lesion and of the temporal field on the opposite side. Each optic tract passes backwards and, bending round the lateral aspect of the mid brain, reaches the lateral geniculate body where the majority of its fibres end. The optic radiations arise in the geniculate body, which is the primary optic centre, and pass to the visual cortex. Other fibres in the optic tracts pass to the superior quadrigeminal bodies. These fibres are not visual in function, but are concerned in reflex pupillary reactions to light and to accommodation. Owing to the involvement of these fibres in optic tract and nerve lesions the visual disturbance may be associated with alteration of the pupillary reactions. Thus blindness due to a complete lesion of the optic nerve is associated with a large immobile pupil, while in optic tract lesions the illumination of the blind field of the retina does not provoke a light reaction (Wernicke's hemianopic pupil reaction).

It is interesting to note here that hemianopia or blindness, associated with lesions of one or both visual regions of the cortex respectively, is not accompanied by loss of pupillary light reaction, a point of some importance in the localising diagnosis of lesions of the visual system (*vide* Fig. 20).

Many affections of the optic nerve within the eye do not come in question here, such as neuroretinitis or papilloedema from raised intracranial tension.

The optic nerve may be damaged in fractures of the middle fossa of the skull which extend to the optic foramen. Sudden and complete blindness and subsequent primary optic atrophy result from such an injury. Tumours in or above the sella turcica may compress the nerve or chiasma, and produce the

visual disturbances described in the chapter on "Intracranial Tumours." The visible result of this compression is primary optic atrophy. Tumours of the temporo-sphenoidal lobe may press mesially upon the optic tract and produce the visual and pupillary symptoms described above.

Symptoms.—The clinical manifestations of lesions of the optic nerve are (1) impairment or loss of vision over part or all of the visual field; (2) impairment or abolition of the pupillary light reaction; (3) visible changes in the appearance of the optic disc.

Retrobulbar Neuritis.—Localised lesions of the optic nerve may arise from a variety of causes. The pathological process tends to arise and be most severe in the deep central part of the nerve, with the result that the characteristic visual disturbance is a central scotoma in the field of vision. There is also impaired mobility of the pupil on illumination. If the lesion be close behind the eye there may be some swelling of the disc amounting sometimes to a definite papilloedema. In other cases, no abnormality is seen in the disc during the acute stage of the lesion, but at a varying period of weeks subsequently pallor of the disc appears and a varying degree of primary optic atrophy. The various causes of retrobulbar neuritis are (a) *toxic*: excessive consumption of tobacco produces a recoverable retrobulbar neuritis manifested by a central scotoma. In diabetes progressive retrobulbar neuritis may develop with blindness and optic atrophy. Methyl alcohol may lead to a rapidly developing neuritis with blindness and optic atrophy. (b) *Local septic processes* in the sphenoidal sinuses and ethmoidal cells may rarely produce a retrobulbar neuritis. The frequency of this complication is probably greatly exaggerated, owing to the loose way in which the presence of such suppuration or sepsis is assumed to be present in cases of retrobulbar neuritis in otherwise healthy persons. (c) *Disseminated sclerosis* is the commonest cause of retrobulbar neuritis in otherwise healthy young adults, women particularly. The symptoms have been described in the chapter dealing with this disease (*vide* p. 824). (See also *Neuromyelitis Optica*, p. 829.)

THE OCULOMOTOR NERVES: THIRD, FOURTH, AND SIXTH

The cells of origin of these nerves lie in the grey matter close to the middle line in series from before backwards, the third and fourth nerve nuclei in the mid-brain, and the sixth in the pons. The fibres of the third and sixth pass ventrally to emerge on the under surface of the brain stem at the anterior

and posterior ends of the pons respectively, while those of the fourth pass dorsally, decussate and emerge on the dorsal aspect of the brain stem posterior to the posterior corpus quadrigeminum

The third nerve supplies (1) the internal (medial) superior, and inferior recti, the inferior oblique and levator palpebrae superioris, and (2) the ciliary muscle and the sphincter pupillae. The fourth nerve supplies the superior oblique muscle. The sixth nerve supplies the external (lateral) rectus muscle.

General Symptoms of Ocular Paralysis—Loss of power in ocular muscles produces limitation of movement of the eyes, non-correspondence of the visual axes (*i.e.*, squint), diplopia, secondary deviation of the sound eye, and erroneous projection. The limitation of movement is in the direction of the weak or paralysed muscle and as a consequence ocular movements employing a paralysed muscle result in squint. This squint is due not only to failure of the affected eye to make a normal excursion but also to a secondary deviation of the sound eye that is, an excessive movement of the sound eye in the desired direction the result of the extreme effort made to swing the weak eye to the required position. A further result of the secondary deviation of the sound eye is erroneous projection of the visual image. This arises as follows. The increased effort at innervation of the weak eye corresponds to a greater degree of movement than is actually taking place, and the image tends to be projected in space to the point at which the degree of effort made corresponds when ocular movement is normal. Thus the image is projected in the direction in which the eye is unable to move, and farther in that direction than the object actually is. Erroneous projection is always most pronounced when the affected eye alone is being used and is not present when only the normal eye is in use. The diplopia or double vision results from the non-parallelism of the optic axes.

• **Lesions of the Third Nerve** produce when complete loss of all ocular movement except outward movement (which is intact) and slight downward and inward movement. Diplopia is present in all movements involving the paralysed muscles. There is complete ptosis with an associated compensatory overaction of frontalis and elevation of the eyebrow, and dilatation with immobility of the pupil and ciliary paralysis with loss of accommodation. Partial lesions are common, and in these circumstances the various extrinsic muscles are very unequally affected and the intrinsic muscles may escape or vice versa.

Lesions of the Fourth Nerve are rare, apart from associated lesions of the third or sixth, but when isolated produce diplopia

in all directions when the gaze is directed below the horizontal. The patient inclines the head downwards and towards the sound side. There is a very slight convergent squint.

Lesions of the Sixth Nerve produce loss of outward movement with convergent squint and diplopia. The two images are parallel and uncrossed.

Abnormalities of Pupillary Action—The size and reactions of the pupil depend on the action of the circular muscle fibres (sphincter pupillæ) which are innervated by the third nerve, and of the radiating fibres which are innervated by the sympathetic. The iris has three actions: (a) reflex contraction of the sphincter to light, (b) reflex contraction of the dilator fibres on cutaneous stimulation, and (c) contraction of the sphincter, in association with contraction of the ciliary muscle, on accommodation.

The anomalies of pupillary reaction which may occur are (1) paralysis of accommodation—the pupil does not contract on accommodation, as a result near vision is blurred. (2) Loss of the light reflex—since both eyes react to illumination of one, each eye must be tested separately in a strong diffuse light.

In third nerve lesions with associated sympathetic paralysis the pupil is of moderate size and completely immobile. In isolated sympathetic paralysis the pupil is small, there is onophthalmos (from paralysis of orbital muscle) and narrowing of the palpebral fissure from paralysis of the smooth muscle fibres in levator palpebræ superioris.

Loss of the light reflex may occur as an isolated phenomenon, but is usually associated with myosis, irregularity, and inequality of the pupils.

Tonic Pupil—A rare condition has been described by this name. One or both eyes may be affected. The pupil is of normal size, or larger than its fellow when this is not affected. It does not respond to light, and its response on convergence is very slow. The patient is commonly a healthy young woman, but sometimes this phenomenon is accompanied by a complete absence of tendon jerks. Whether it occurs alone or with this loss of reflexes, the condition is not syphilitic in origin and is not related to tabes dorsalis. Occasionally, when the pupil affection is unilateral the patient may complain of some blurring of near vision. Otherwise the condition is symptomless and of no practical significance, but it is important not to confuse it with tabes dorsalis.

Compound and Nuclear Ocular Paralysis—Loss of convergence and of accommodation, when lateral eye movement is intact, is a rare result of a nuclear lesion. Loss of vertical

movement with paralysis of the levators is a common sequel of mid brain lesions involving the supranuclear mechanisms for ocular movement. Loss of conjugate deviation of the eyes is a transient result of cerebral lesions, and may also occur in pontine lesions.

Ætiology of Ocular Paralysis—Ocular paralysis may be due to peripheral lesions of the oculomotor nerves in the orbit or in their intracranial course, or to central lesions involving the nerve fibres, the nuclei, or the supranuclear co-ordinating centres in the mid brain and pons.

Peripheral Lesions may be due to injury, that is to fractures involving the walls of the orbit or the middle fossa of the skull or sometimes to blows without fracture. The lesion is usually unilateral and may affect one or more of the nerves. A form of neuritis of the oculomotor nerves allied to the familiar Bell's palsy occasionally occurs. It may be associated with fifth nerve involvement. It is acute in onset, accompanied by severe pain in the face and in the eye itself, and with paralysis of one or more ocular muscles. Periostitis of the bones entering into the sphenoidal (superior orbital) fissure has been suggested as the cause of the condition. Within the skull a meningitic process is usually in question, and syphilis is by far the commonest cause of paralysis of oculomotor nerves in this situation. Other lesions are tumours of the base of the skull, chiasmal tumours, carotid aneurysm (perhaps the commonest cause of isolated and unilateral third nerve palsy), cavernous sinus thrombosis and subarachnoid hæmorrhage. Occasionally isolated sixth nerve paralysis occurs in elderly subjects for no discoverable reason but may possibly be due to pressure on the nerve of a distorted atheromatous carotid artery. In association with acute mastoid disease in children the development of severe neuralgic pain in the side of the head and face may be followed by a sixth nerve paralysis with squint and diplopia. This is known as *Gradenigo's syndrome* and has already been referred to (p. 816). It is thought to be due to a localised meningitis at the tip of the petrous bone where fifth and sixth nerves lie in close proximity. Recovery is the rule though surgical treatment of the mastoid disease may first be required.

Central Lesions arise in a variety of conditions, including disseminated sclerosis, lethargic encephalitis, focal lesions of whatever nature in pons or mid brain, diphtheria (accommodation paralysis), and in the so-called ophthalmoplegic migraine. With lesions in this situation the paralysis may be nuclear or supranuclear in character. Ocular paralysis of both peripheral

and central types may be seen in *tubercles dorsalis* while pupillary abnormalities (Argyll Robertson pupil) myosis irregularity and inequality may occur in all forms of neurosyphilis

In rare instances a chronic nuclear ophthalmoplegia is associated with chronic bulbar palsy, or progressive muscular atrophy

THE TRIGEMINAL NERVE

Anatomy—This is the largest of the cranial nerves. It has motor and sensory roots and on the latter is the Gasserian (trigeminal) ganglion. The larger sensory division supplies sensory fibres to the anterior part of the scalp eyes nose mouth and parts of the ear and tongue as well as the dura mater. The motor portion supplies the masticatory muscles. The cells of origin of the motor root lie beneath the floor of the fourth ventricle in the upper part of the pons. The larger sensory portion sends its fibres into a long column of cells which extends caudally as far as the third cervical segment of the cord and lies at the tip of the posterior horn in the substantia gelatinosa Rolandi and in the medulla lies in the lateral portion. It also extends forward into the pons close to the motor nucleus. The motor and sensory roots leave the pons on its antero-lateral surface side by side in a sheath of dura mater known as the *cavum Meckelii* (*cavum trigeminale*) on the tip of the petrous portion of the temporal bone. Here the sensory root enters the Gasserian ganglion from which emerge the three sensory divisions of the nerve the ophthalmic which enters the orbit the maxillary which leaves the skull by the foramen rotundum and the mandibular or third division which leaves the skull by the foramen ovale. The ophthalmic division supplies sensory fibres to the eye lacrimal gland the meninges and the skin of the anterior part of the scalp and of the face above the eye. The maxillary division supplies the skin of the face from the upper lip to the lower eyelid inclusive and laterally as far as the pinna the upper jaw and teeth and the lower part of the nasal cavity.

The mandibular division supplies the side of the face the pinna and external auditory meatus the greater part of the tongue the mucous membrane of the mouth lower teeth gums and Eustachian (pharyngotympanic) tube. The motor root supplies the masseter temporal pterygoid mylohyoid digastric (anterior belly) tensor palati and tensor tympani muscles.

Symptomatology—Lesions of the fifth nerve produce sensory loss within the distribution of the nerve and

paræsthesiæ. In slowly progressive lesions the earliest manifestation of sensory change is diminution or loss of the corneal reflex. Severe pain, like that of trigeminal neuralgia, does not accompany gross lesions of the nerve. —Wasting and weakness of the muscles named above accompany involvement of the motor root of the nerve. In unilateral lesions the jaw deviates to the side of the lesion, pushed over by the unantagonised external (lateral) pterygoid muscles of the opposite side. Wasting of temporal and masseter muscles is visible, and on clenching the jaw weakness or paralysis of these muscles can be felt on palpation.

Ætiology.—Herpes zoster of the Gasserian (trigeminal) ganglion may produce a herpetic eruption with intense pain over the ophthalmic division. Sensory loss of the cornea leads to intractable ulceration. In its intracranial course the nerve may be involved in any of the processes mentioned in connection with the oculomotor nerves. In tabes dorsalis an area of analgesia over the nose and adjacent skin is common, while in syringomyelia the territory of the fifth nerve may be affected when the spinal root of the nerve is involved in the lesion.

TRIGEMINAL NEURALGIA (TIC DOULOUREUX)

Trigeminal neuralgia is a malady of unknown origin and with no discoverable lesion, of which the expression is the occurrence of paroxysms of intense pain in the distribution of one or more divisions of the fifth nerve. It is not comparable with any other variety of neuralgia in that, although it may endure for many years, no structural lesion of the fifth nerve ever develops and no objective clinical signs of impaired function in the nerve appear.

Ætiology.—It is pre-eminently a malady of elderly persons, although it occurs exceptionally in young adults and sometimes in middle-aged persons. The two sexes are equally affected. Nothing is known of any causal factors. Since it may develop in persons who have been completely edentulous for a number of years, septic conditions in the mouth or tooth sockets cannot stand in any essential relation to it. In the subjects of the malady it is prone to appear especially in cold, damp weather, and in the presence of debilitating factors.

Symptomatology.—The symptoms tend to increase steadily in severity over a number of years. At first the periods during which paroxysms occur are comparatively short, amounting to one or two weeks, and are separated by intervals of many

months. Later, these periods increase in length and frequency, and ultimately the subject may never be wholly free from pain. Similarly, both the distribution and severity of the pain tend to increase with the passage of years. Occasionally, however, the malady disappears after a few periods of paroxysms.

Of the three divisions of the nerve, the second and third are most frequently affected. It is rare for pain to occur in the distribution of the first division unless it is also present in the other two divisions, but neuralgia confined to either of the two latter may occur. Not only may pain spread over face and scalp, but it may extend down the side of the neck to the region of the shoulder and be present in the gums, tongue, the fauces, and ear.

The pain may be of terrible intensity, and is described as being like "red hot needles," "lightning stabs," "shoots of pain," and many other descriptive terms are used which indicate both the neuralgic character of the pain and its severity. Each paroxysm begins acutely, and consists of a rapid series of pains which wax to a maximum and rapidly wane. It may last for from ten to sixty seconds and in severe cases is accompanied by free lacrimation and salivation and by reflex twitchings of the face. When the paroxysms are of great frequency a residual aching pain may bridge the intervals between them, so that the patient is never free from pain. Although during the period in which they are occurring paroxysms may come on spontaneously, yet they are provoked by any movement of the face such as speaking, chewing, or expressional movements. Further, touching the face or currents of cold air playing upon it, may start a paroxysm. Such patients often are compelled to abstain from shaving or from washing the face or teeth on the affected side for many days, and they remain motionless and in terror of pain for hours at a time.

Pressure over the branches of the nerve at their points of exit from the bone will provoke a paroxysm.

Unilateral furring of the tongue is common when the third division of the nerve is the seat of pain.

No objective physical signs of a lesion of the nerve are to be found. The corneal reflex is intact, cutaneous sensibility is normal, and the motor division of the nerve is unaffected.

Naturally, depression and debility attend the frequent and persistent occurrence of paroxysms of neuralgia (see also Glossopharyngeal Neuralgia p. 895).

Diagnosis.—The appearance of the patient during a paroxysm, the history of the illness and the absence of

objective physical signs render diagnosis easy. Gross lesions of the fifth nerve, such as compression by a gummatous meningitis or by a tumour, produce objective signs of impaired activity—loss of the corneal reflex, sensory loss, neuropathic keratitis, and also associated signs of involvement of neighbouring nervous structures. They do not produce pain of any severity, or in any way resembling that of trigeminal neuralgia.

Treatment.—When a case of the malady comes under observation early in its course, it is important to remember that the periods during which paroxysms may be expected to continue is short and may be followed by a long interval exceeding a year of complete freedom from pain. This should prevent us from taking steps of a more radical nature than the circumstances demand. In short, many cases of trigeminal neuralgia can be adequately treated over a period of several years by simple drug medication, and do not require any form of surgical procedure, be it alcohol injection into the nerve or actual removal of the Gasserian ganglion and its roots.

The drugs most valuable for the purpose are tincture of gelsemium, the bromides, acetyl salicylic acid, and allied substances. A useful combination in cases of some severity is tincture of gelsemium, ℞, luminal sodium gr $\frac{1}{2}$, sodium bromide gr \mathfrak{xx} , liquor arsenicæ, ℞iij. If this or some similar combination does not give absolute freedom from pain it so reduces its intensity as to allow of the proper nutrition and rest of the subject, both of which are essential elements in treatment.

The removal of teeth is usually resorted to, but does not materially relieve the frequency or the intensity of the paroxysms. This question must be considered wholly from the dental point of view, and it is rarely justifiable to remove teeth for no other reason than the relief of pain. In long-standing and severe cases drugs may give no relief, and recourse must then be had to alcohol injection into one or more divisions of the nerve. This is a skilled procedure, and in inexperienced hands may produce serious and untoward effects owing to misdirection of the injecting needle and fluid. The method consists in the introduction of a long needle into the region of the foramen ovale and the injection of 80 per cent alcohol (10 to 50 minims) into the ganglion or the second and third divisions of the nerve. A successful injection gives complete relief for a period up to two or more years. Final and absolute relief is given by ablation of the Gasserian ganglion, but permanent anæsthesia of cornea and face on the affected side results.

FACIAL HEMIATROPHY—This is a rare malady characterised by progressive atrophy of skin, subcutaneous tissues, muscle and bone within the sensory territory of the trigeminal nerve. There is neither paralysis nor sensory loss in the affected tissues. Its causation and the pathological process responsible for the condition are both unknown. It is more common in females than in males, and develops gradually in early adult life.

The tissue atrophy may extend to the whole area innervated by the trigeminal nerve, or be confined to one or more divisions of this area. It may start in a restricted spot and spread from this. The skin becomes thinned and pale, the subcutaneous fat disappears, the muscles waste, and then the bony structures of the face gradually shrink, including the alveolar processes of the jaws. The whole affected half of the face is shrunken and unsightly. Diagnosis is simple. The process is not influenced by any known method of treatment.

THE FACIAL NERVE

Anatomy.—The cells of origin of the seventh nerve lie in the lateral part of the tegmentum of the pons, in relatively the same position as that of the nucleus ambiguus in the medulla oblongata. The nerve fibres pass dorsally and medially towards the floor of the fourth ventricle and bending round the sixth nerve nucleus turn laterally and ventrally, to emerge from the brain stem at the junction of pons and medulla. They innervate all the muscles of facial expression, the platysma, and stapedius. The nervus intermedius of Wrisberg has been described as part of the facial nerve, but its fibres are afferent and have entirely different connections. They arise in the cells of the geniculate (facial) ganglion, which is attached to, but not functionally connected with, the seventh nerve. The peripheral fibres of the ganglion pass with the seventh nerve, and then into the chorda tympani, with which they are distributed to the anterior two thirds of the tongue, supplying this with taste fibres and end organs. The central branches unite to form the nervus intermedius, which enters the pons ventral to the seventh nerve and, together with the afferent taste fibres of the glossopharyngeal nerve from the posterior third of the tongue, terminate in the nucleus of the tractus solitarius.

Leaving the pons, the facial or seventh nerve passes laterally with the eighth nerve into the internal auditory meatus of the petrous bone, where, joined by the nervus intermedius, it

passes through the aqueduct of Fallopius (facial nerve canal) in a curved course, to emerge from the stylo-mastoid foramen. The chorda tympani leaves the nerve above this foramen. The facial nerve may be involved by disease at any part of its course: in the pons by tumours, vascular lesions, inflammatory lesions such as lethargic encephalitis or poliomyelitis; in its intracranial course by tumours of the cerebello-pontine angle; by meningitis in the petrous bone or by caries from middle ear disease; at the stylo-mastoid foramen by the process which causes the familiar Bell's palsy; and in its peripheral course by parotid tumours or injury. The typical picture of facial paralysis is seen in Bell's palsy.

BELL'S PALSY—*Ætiology*.—Nothing is certainly known of the causes of this very common malady. It is on the whole an affection of adult life, at any period of which it may occur. It is said to appear in cold and inclement weather, but while cold and exposure must remain hypothetical causes, it may certainly be said that there is a periodicity in the occurrence of facial palsy which is most often seen in the late autumn and early winter, and in the out-patient practice of a neurological hospital a small "crop" of cases may be expected at this time of year. Of these, some are certainly the results of geniculate herpes, and the proportion of cases of Bell's palsy due to this cause is not known.

***Symptomatology*.**—Immediately preceding the onset of the paralysis, it is common for the patient to complain of aching or of neuralgic pains in the region of the mastoid and the angle of the jaw, and of stiffness of the muscles of the affected side of the neck. This is followed by sudden and total paralysis of the nerve. The sequence of events has led to the view that an inflammatory process has extended from these muscular and fascial structures to the sheath of the emerging nerve, whence it spreads upwards into the bony canal. Here swelling leads to constriction of the nerve and to paralysis. The muscles of the affected half of the face are paralysed and toneless, and in all movements that half of the face remains immobile. The angle of the mouth and the eyebrow droop, and the frontal furrows are flattened out. The lower eyelid sags and tears run over its edge. Attempts to close the eye are followed by a slight drooping of the upper lid from relaxation of levator palpebræ superioris, but the lids are not approximated and remain apart even during sleep. Further, the globe of the eye is seen to turn up even more than is the case on the normal side (if the lid of this side be kept open by the observer when making the comparison).

Fluids taken into the mouth trickle from the paralysed angle, and the patient cannot whistle or blow out his cheeks without allowing air to escape from this angle. The platysma is also paralysed. Paralysis of the buccinator allows food to collect between gums and cheek. If the inflammatory process involve the nerve between the geniculate ganglion and the point distally at which the peripheral fibres of this ganglion leave the nerve to pass into the chorda tympani, then taste is lost over the anterior two thirds of the tongue. Lesions of the seventh nerve at other parts are not associated with loss of taste. Paralysis of the stapedius may be followed by increased auditory acuity and by subjective clicking noises in the ear.

Course—The duration varies from a week or two to several months. In severe lesions the faradic excitability of the nerve diminishes and is lost during the second week. The reaction of degeneration is then obtainable from the facial muscles and if present it affords valuable prognostic information. If at the end of four weeks the muscles are inexcitable when faradic stimulation is used, and no visible recovery of function is present, long delayed and partial recovery may be expected. With the return of voluntary power some contracture develops in all but the most rapidly recovering cases. It is most marked in the orbicularis palpebrarum (orbicularis oculi) and leads to great narrowing of the palpebral fissure and in the zygomatic muscles where it leads to exaggeration of the nasolabial fold. There is also a tendency to associated overaction. Thus voluntary closure of the eyelids is accompanied by deepening of the nasolabial fold and vice versa. In cases of imperfect recovery this contracture tends to mask the degree of paralysis but it may be so severe as almost to approximate the lids.

Occasionally a facial palsy may be bilateral and in this case the second half of the face is affected a few days later than that first involved. In the absence of other signs such a bilateral affection does not necessarily, or even commonly, indicate the presence of some intrapontine lesion. Recurrence of facial palsy is rarely seen, but is known to occur.

Prognosis—The indications upon which this must be based are given above. Even in severe cases which show no recovery after several months it is never necessary to despair, since improvement continues well into the second year and severe permanent paralysis is rare.

Treatment—At the onset, hot applications to the region of the ear and the administration of salicylates are indicated. Later, gentle massage to the facial muscles should be continued until recovery is well advanced. Electrical stimulation is

valueless and probably leads to an increased contracture. A sling made of a piece of silver wire may be used to prevent stretching of the muscles round the mouth. It is bent at each end and one end passes behind the ear and the other is adjusted to curl round the angle of the mouth. A length of thin rubber tubing may be placed round the oral end of the wire.

GENICULATE HERPES—The sequence of events is commonly as follows: there is severe neuralgic pain in the region of the external auditory meatus and adjacent parts of the pinna. There may also be pain in the fauces and in the anterior part of the tongue on the same side. An eruption of herpetic vesicles then makes its appearance in the pinna and sometimes also a few vesicles are to be seen on the pillars of the fauces and on the anterior part of the tongue. In severe cases the pinna may swell considerably and the appearances of a sore throat be present. There may also be a febrile reaction and much malaise. When the vesicles in the ear burst there is a watery secretion which has been mistaken for an otorrhœa.

Some two weeks after the onset and while the ruptured vesicles are still unhealed a facial palsy develops with all the features already described.

Associated with the geniculate herpes an eruption may also be seen in the distribution of the second cervical nerve (posterior part of scalp and below the jaw round towards the chin).

FACIAL SPASM—This is a malady of elderly persons of unknown ætiology. The facial muscles go into momentary contraction in the form of an irregular clonic spasm. There may be a slight degree of maintained tonic spasm underlying this. It is always increased by emotion or by voluntary facial movements. As a rule it persists indefinitely and responds badly to all forms of treatment. In the most severe cases alleviation has been given by alcohol injections into the facial nerve thus replacing a spasm by paralysis which may be temporary or more or less permanent. Clonic facial spasm may also be produced by compressing lesions of the nerve or occur as part or all of a Jacksonian fit.

THE EIGHTH NERVE

This nerve comprises sensory and non sensory components. The sensory component is the cochlear nerve which subserves the auditory function. The non sensory component is the vestibular nerve which subserves various reflex reactions

concerned in the co ordination of movement and posture. The two components are distinct peripherally and have separate central connections.

The nerves may be involved in their central course by focal lesions of the brain stem in their intracranial course by tumours of the cerebello pontine angle or by gummatous meningitis in this region. The cochlear and vestibular end organs may be involved by suppurative processes in the petrous part of the temporal bone.

Symptomatology of the Cochlear Nerve—Lesions of this nerve produce either deafness or tinnitus or both combined. Slowly progressive pathological processes are prone to produce slowly developing deafness associated with tinnitus as may be seen in the case of eighth nerve tumours but these two symptoms are seen in a variety of conditions within the petrous bone itself in which the nervous elements are secondarily involved. Deafness due to a lesion of the nerve (nerve deafness) may be differentiated from middle ear deafness by the following tests. *The Weber test* the foot of a vibrating tuning fork is placed upon the forehead. With nerve deafness the sound is best heard on the normal side while in middle ear deafness it is best heard on the affected side. *The Rinne test* normally a vibrating fork is best heard when held slightly away from the ear. If it be placed upon the mastoid until it be no longer heard and then approached to the meatus it is heard again. In short air conduction is better than bone conduction. In middle ear disease this relationship is reversed and bone conduction is better than air conduction. In cochlear lesions both air and bone conductions are proportionately reduced. It may be added that the accurate differentiation of nerve from middle ear deafness may be a matter of considerable difficulty even in experienced hands.

Tinnitus is an extremely common symptom and may be due to local lesions in the external auditory meatus in the middle ear in the cochlear apparatus or in the cochlear nerve within the skull. *Occurring as an independent symptom it is commonly due to disease of the cochlea* when it is associated with slowly progressive deafness. It may occur in elderly subjects presenting signs of arterial degeneration and may prove a distressing and intractable symptom. The noises are described as whistling roaring buzzing noises or as like the sound of rushing or falling water.

Diagnosis—The recognition of tinnitus presents no difficulty, and its cause must be determined by a systematic examination of the nervous system generally and of the

auditory apparatus When due to intracranial lesions diagnosis depends upon associated signs of nervous involvement

Treatment—Occurring as an independent symptom it is generally intractable, but its intensity may be relieved by the administration of potassium iodide, the bromides, hydrobromic acid, or luminal

Symptomatology of the Vestibular Nerve—The labyrinth has two components the semicircular canals and the otolith organs (utricle and saccule) The former are stimulated by movement, the latter by changes in the position of the head The symptomatology of labyrinthine disease has not been fully elucidated in man, and the majority of symptoms attributable to this organ arise from disease of the semicircular canals. Vertigo is the most striking and best recognised symptom

Vertigo—True vertigo is a subjective sense of rotation either of self or of surrounding objects In intense vertigo consciousness may be disturbed or lost

Vertigo may occur as a symptom in cerebellar disease in lesions of the vestibular nerve and of the labyrinth and also in cardiovascular disease and in association with nausea and vomiting In all these conditions the symptoms and signs of the underlying condition are to be found Almost all cases of vertigo occurring in the absence of signs of disease elsewhere are due to chronic degenerative changes in nerve endings in the labyrinth The functions of the semicircular canals may be investigated by studying the nystagmus resulting from rotation of the patient or from irrigation of the external auditory meatus with hot and cold water These tests are highly complicated and require skilled employment

MÉRIÈRE'S SYNDROME—*Ætiology*—This is a malady of adults more frequently of men than of women The nature of the disease of the labyrinth is uncertain but is probably degenerative in origin The syndrome is not usually found in association with suppurative processes

Symptomatology—The malady is characterised by sudden accesses of intense vertigo, with slighter interparoxysmal vertigo These attacks occur at varying intervals of a few days or of a few weeks They may be precipitated by sudden movements by sneezing or blowing the nose, and there are reasons for supposing that reflexes arising in the nose may precipitate an attack The sense of rotation may be purely subjective, or there may be an actual tendency to turn before falling The subjective symptom may be of rotation of self or of surrounding objects or of both So intense is the oddness that the subject usually falls down sometimes with

alarming suddenness. Consciousness may be momentarily lost. If the vertigo persist there is nausea and vomiting, the patient is pale and perspires profusely. The attack tends to pass off gradually, the symptoms being aggravated by any movement of the patient's head. Nystagmus and rarely, diplopia may occur during the height of the attack. Associated deafness and tinnitus are present in many cases, if not at the onset of the malady then later during its course. They are unilateral.

Course and Prognosis—In most cases the early attacks are the most severe, and the disease tends slowly to improvement. In other cases there is progressive deafness and when this is complete in the affected ear the vertiginous attacks cease. Under treatment some degree of alleviation occurs in most cases.

Diagnosis—The occurrence of acute attacks of intense vertigo, especially when there are associated slight unilateral deafness with tinnitus and no signs of organic nervous disease, is characteristic of Menière's syndrome. In epilepsy persistent deafness and tinnitus are absent, while in apoplectic seizures some objective signs of nervous lesion will be found and vertigo is absent or transient and slight.

Treatment—Luminal (gr $\frac{1}{2}$ t.i.d.) or bromides in doses of from 10 to 20 gr three times daily with dilute hydrobromic acid (M 15 to 60) have almost constantly a strikingly beneficial result. Other cases respond favourably to the salicylates, especially to aspirin.

THE NINTH, TENTH, AND ELEVENTH NERVES

These nerves are so intimately related in their central connections, and are so frequently affected simultaneously in their contiguous peripheral course, that they are best considered together as the glosso-pharyngeal-vagus-accessorius complex. They contain both motor and sensory fibres. The motor fibres fall into two groups: (1) a *somato-motor* group which innervates the musculature of the pharynx, larynx, palate, sternomastoid, and trapezius. The cells of origin lie in the nucleus ambiguus and its caudal extension. The latter reaches as far as the third cervical segment, where it forms the spinal nucleus of the accessory nerve. The musculature is represented in this columnar nuclear mass from before backwards in the order named above. (2) a *viscero-motor* group which supplies the involuntary musculature of the alimentary tract and of the air passages and which arises in the dorsal nucleus of the vagus. The sensory fibres also fall into two

groups—a *somato sensory group*, the fibres of which end centrally in the substantia gelatinosa Rolandi and peripherally supply common sensation to the ear, mouth, pharynx, and the upper part of the respiratory tract, and a larger *viscero-sensory group* which receives afferent fibres from the thoracic and abdominal viscera.

The three nerve trunks leave the skull together by the jugular foramen. The glossopharyngeal nerve ends in the posterior third of the tongue, the vagus extends downwards through the neck and thorax to the abdomen, while the spinal accessory (bulbar and spinal portions) sends its bulbar fibres to join the vagus and its spinal fibres pass to the sternomastoid and trapezius muscles. These three nerves may be involved in focal medullary lesions and by lesions at the base of the skull or in the neck. Various symptom-complexes have been described corresponding to lesions in these different situations.

Lesions in the Medulla Oblongata—These are not uncommon and may be the result of focal thrombosis, chronic bulbar palsy or of syringomyelia with bulbar extension. The symptoms (*syndrome of Atellis*) are unilateral paralysis of the soft palate, pharyngeal muscles, and larynx with an associated crossed hemianæsthesia of syringomyelic type affecting pain and thermal sensibility.

Paralysis of the soft palate is also a common symptom in diphtheritic paralysis and is due to a lesion of the nucleus in the medulla.

Lesions at the Base of the Skull, either of the nature of new growth, fractures, or gunshot wounds often produce associated ninth, tenth and eleventh nerve palsies. The following syndromes have been described: *Schmidt's syndrome* unilateral paralysis of pharynx, larynx, palate, sternomastoid and trapezius; *Jackson's syndrome* like Schmidt's syndrome, with the addition of a hypoglossal nerve palsy, but in incomplete forms the vocal cord may remain intact.

Lesions in the Neck—*Tapia's syndrome* occurs in injuries high in the neck, and consists in unilateral paralysis of tongue and vocal cord (vocal fold) the palate being intact. The lesion is below the off-set of the pharyngeal branches.

The characteristic sign of involvement of the glossopharyngeal nerve is sensory loss over the upper part of the pharynx and loss of taste in the posterior third of the tongue.

The characteristic signs of lesions of the vagus nerve are pharyngeal and laryngeal paralysis. In pharyngeal paralysis the soft palate lies low on the affected side and does not rise

on phonation and there is loss of the pharyngeal reflex on that side. Also there is the so called "curtain movement" of the posterior pharyngeal wall, which moves across to the normal side on swallowing. Bilateral pharyngeal paralysis may occur in diphtheritic paralysis.

Total unilateral laryngeal paralysis results from high level lesions of the vagus. The affected vocal cord (vocal fold) lies in the cadaveric position. There is weakening of the voice, but no stridor.

Recurrent laryngeal nerve lesions, or lesions of the vagus below the offset of the superior laryngeal branches, produce paralysis of the abductor of the vocal cords. The affected vocal cord lies up against the median plane and does not move on phonation or on respiration. In bilateral abductor paralysis both vocal cords lie approximated in the midline and do not recede during inspiration. There is marked inspiratory stridor and considerable danger of asphyxiation (*vide p. 859, tabes dorsalis*).

Lesions of the Spinal Accessory Nerve—The bulbar portion joins the vagus at the ganglion of the trunk (inferior ganglion of vagus) and probably provides the majority of the motor fibres which reach the larynx through the vagus. It does not therefore need separate consideration. Lesions of the spinal portion produce sternomastoid and trapezius paralysis. It is paralysis of the latter which causes definite disability. The shoulder on the affected side cannot be raised fully. The scapula tends to fall away from the midline and to rotate so that its superior angle lies higher than normal, and protrudes as a hump on the contour of the neck as seen from in front. There is also some winging of the scapula, like that seen in serratus palsy, but most marked when the arm is held extended forwards below the horizontal, whereas the winging of serratus magnus (*s. anterior*) paralysis is maximal with the arm above the horizontal.

Ætiology of Glosso-pharyngeal-Vagus-Accessory Lesions—In the medulla, chronic bulbar palsy, focal thrombosis, tumours, syringohulbia, and diphtheritic toxic lesions may all produce symptoms referable to one or more of these nerves. In their intracranial course, tumours, or syphilitic meningitis may involve one or more of them. At the base of the skull injuries or new growth may involve all three in the region of the jugular foramen, while in the neck, injuries, new growths, or aneurysms may compress them. The vagus may be involved in the thorax (recurrent laryngeal paralysis) by aneurysm.

Glossopharyngeal Neuralgia—This comparatively rare condition is in the characteristics of the pain very like trigeminal

neuralgia The patient complains of accesses of severe neuralgic pain in the region of the throat and ear The paroxysm is commonly excited by the act of swallowing The patient is usually a middle aged or elderly man

Treatment resembles that of trigeminal neuralgia in the matter of medication In severe and intractable cases division of the glosso pharyngeal nerve within the skull has been successfully performed

THE HYPOGLOSSAL NERVE

The twelfth nerve is an exclusively motor nerve which arises in a group of cells on the floor of the fourth ventricle close to the median plane Its fibres innervate the muscles of the tongue and some of the elevators of the hyoid bone (hyoglossus and genio hyoid)

Ætiology of Lesions—The nerve nucleus may be involved in medullary lesions particularly in chronic bulbar paralysis syringobulbia tumour, thrombosis, and sometimes in tabes dorsalis The two nuclei lying close together are generally both affected The nerve may be affected in its intracranial course by syphilitic meningitis or new growth Peripherally it may be involved alone or, as we have seen with vagus and accessorius in any disease process deep in the neck

Symptomatology—Lesions of the cortico bulbar (upper motor) neurones at any level higher than the pons may affect the tongue rendering the organ spastic and small and causing protrusion towards the side of the lesion

Nuclear or infranuclear lesions lead to unilateral paralysis the organ when protruded being thrust towards the paralysed side by the unopposed muscles of the normal half, and to wasting and fibrillation The organ on the affected side is sbrunken and wrinkled and is in constant fibrillation

COMPRESSION OF THE SPINAL CORD

The spinal cord may be subjected to gradual compression or may be suddenly crushed The symptom-complex of sudden and complete compression is that of anatomical transection of the cord, and will be described under the heading of 'Total Transverse Lesions of the Cord' (vide p 907)

I GRADUAL COMPRESSION, apart from injury to the spine is the common form of compression and may be due to a variety

Ætiology—The cord may be gradually compressed by disease of the vertebral column, of the meninges, or of the nerve roots. Further, tumours developing in the substance of the cord also effect compression as they increase in size.

The form of vertebral disease responsible for most cases of compression paraplegia is tuberculous caries. This is commonly situated at some level between the fourth and tenth thoracic vertebrae, and may compress the cord in one of two ways. A tuberculous abscess forming in the vertebral body may bulge backwards into the vertebral canal on either side of the posterior common ligament, or tuberculous granulation tissue may invade the canal and directly involving the theca, produce a localised meningitis with resulting constriction of the cord. Children and young adults form the majority of patients so affected.

Osteomyelitis and, more commonly malignant disease of the vertebrae may cause cord compression. The latter is especially common after excision of the breast for carcinoma. In this case it is the lumbar cord that generally suffers and the clinical picture is a very characteristic one. Primary sarcoma and hypernephroma may also invade the vertebrae and lead to compression of the cord. Finally, erosion of the vertebral column by aortic aneurysm may produce a like result.

The meningeal diseases which may lead to cord compression are syphilitic pachymeningitis, particularly in the cervical region, localised meningitis from vertebral osteomyelitis, and meningeal tumours.

Similar in nature to meningeal tumours which are mainly intrathecal, are the benign fibromata which sometimes develop on the spinal nerve roots and lead to compression of the cord.

Morbid Anatomy—The cord may be compressed to a ribbon-like structure at the level of compression, or in the case of a tumour arising on a nerve root, the neoplasm may be found to have made for itself a pocket on one side of the cord. Microscopically there may be necrosis of both grey and white matter in the compressed segments, and at its upper and lower limits neuroglial reaction and phagocytic activity are seen, together with venous engorgement. Ascending tracts are found to be degenerated above and descending tracts below the level of the lesion. This descending degeneration, even in longstanding cases of compression, may be very incomplete.

The Cerebrospinal Fluid (*From's Compression Syndrome*)—The compressing lesion may obliterate the subarachnoid space. When this happens the cerebrospinal fluid in the distal portion

of the spicc stagnates and undergoes changes in composition and appearance, approximating more closely to blood plasma in the former respect. The total protein content may rise to many times its normal amount, for example 0.5 or 1.0 per cent. The fluid may also assume a yellowish tinge (xanthochromia). If the compressing lesion be inflammatory in nature (meningitis), there may also be an increase in the cell content of the fluid, the cells present being mononuclears. In slighter degrees of alteration an increase in the protein content may be the only definite abnormality.

Symptomatology—There are minor variations in the clinical picture of spinal cord compression according to the nature of the compressing lesion, but in general the sequence of events is remarkably constant. The symptoms are of two orders: (a) those arising at the level of compression, and (b) those due to interference with the long ascending and descending tracts of the cord.

Of the former the symptoms due to compression of spinal nerve roots are of great diagnostic importance.

At the level of the lesion, both anterior and posterior roots are commonly compressed. The posterior root symptoms are the more constant and prominent. They consist of sharp pains radiating along the course of the root and referred to its distribution. They may be periodic or almost constant. When thoracic roots are bilaterally affected, the pains encircle the trunk and are known as "girdle pains." When a single root is affected on one side the pain is confined to one-half of the body. In the case of the roots which enter into the limb plexuses the pains are referred to the corresponding limb down which they spread. The pain may be accompanied by hyperaesthesia and sensory impairment. Root pains may be the first indication of disease, and may precede all objective signs of root or cord compression by weeks or months. Secondary carcinoma of the spine is frequently ushered in by sudden root pains on exertion, and the occurrence of sudden girdle or back pains in an individual known to have had visceral or mammary carcinoma is of sinister significance.

In the case of fibroma on a spinal nerve root, more or less constant pain in a nerve root distribution may be present for long periods before signs of cord compression appear. On the other hand all such symptoms may be absent in a given case of spinal cord compression. Symptoms referable to ventral roots are not so common and in the case of the roots which lie between the upper and lower limb plexuses may escape notice. In the case of the cervical and lumbosacral roots

however, wasting and fibrillation of corresponding limb muscles is not uncommon. Rarely, irregularly clonic muscular spasm may be present.

The diagnostic importance of root symptoms lies in the fact that they give information as to the level of compression.

The gradual compression of the cord itself leads to progressive interference with conduction in the long spinal tracts, both ascending and descending. Usually motor symptoms appear before sensory changes, and there is often a period in the early evolution of a case of compression when the absence of sensory loss may make segmental localisation impossible. The motor disturbance consists in the gradual development of spastic weakness, with increase of tendon jerks, the appearance of clonus and of the extensor or Babinski type of plantar response. Probably the earliest objective signs are the extensor plantar response, increased tendon jerks, and weakness of dorsiflexion of foot and toes.

As compression becomes more severe, the legs become progressively weaker, and the condition of *paraplegia in extension* develops.

The extensor and plantarflexor groups of muscles in the legs are extremely spastic and go periodically into clonus, in which the whole limb is shaken. The voluntary power of flexion and dorsiflexion wanes far in advance of that of extension and plantarflexion, and the patient, while still able to stand and walk, does so with stiffly held legs and shuffling feet.

Finally, powerful spontaneous flexor spasms make their appearance, all voluntary power disappears, and the limbs come to lie in a position of full flexion, with the knees pressed against the abdominal wall. This is the condition of *paraplegia in flexion*. The knee and ankle jerks may disappear, but stimulation of the sole produces a brisk extensor plantar response with powerful flexion at hip and knee, which is sometimes bilateral.

Soon after the development of early signs of spastic weakness, loss of sensation involving all forms of sensibility makes its appearance, and gradually extends up to the level of the distribution of the posterior root fibres of the segment immediately below the level of compression. Separating the region of sensory impairment from the higher levels of normal sensation, there may be a zone of hyperæsthesia in the distribution of the compressed roots, but this is not a constant finding.

The abdominal reflexes are also abolished early below the level of compression. In the case of compression of the tenth

thoracic spinal segment, for example, we should find spastic paresis of the lower limbs, weakness of the abdominal muscles below the level of the umbilicus, with deviation upwards of the umbilicus on contracting the abdominal wall (Beever's sign), loss of the abdominal reflexes below the umbilicus, and sensory loss below the same level. Thus motor, reflex, and sensory phenomena all contribute to establish the segmental level of compression.

Generally a little later than the establishment of motor and sensory symptoms, disturbances of sphincter control appear. At first, precipitancy of micturition and then periodical evacuation of urine occur, but the bladder is never completely emptied. There is always residual urine after this so-called reflex micturition, and the term overflow incontinence is a more accurate one to use in this connection.

With compression of fairly rapid onset, retention of urine may be the initial sphincter symptom. In respect of the bowel, constipation with faecal incontinence after purgatives are the usual symptoms.

By the time that paraplegia in flexion has developed, voluntary power, sensation and sphincter control are almost if not completely lost below the level of the lesion. Bedsores over the sacrum and trochanters develop, and septic absorption from this source and from cystitis hasten a fatal issue.

There may be certain minor variations in this sequence of events. In the case of secondary carcinoma of the spine, symptoms of root compression predominate, and cord compression may be only a late and terminal phenomenon.

In the case of spinal caries, the symptoms are commonly of equal intensity on both sides, and the cord sustains a generalised compression. With spinal nerve root tumours on the other hand the lateral position of the compressing lesion often leads to wholly or predominantly unilateral signs. A *Brown Sequard syndrome* may develop in these circumstances. The anatomy of the spinal cord and the course of afferent and efferent paths will indicate what this syndrome must be. On the side of the lesion there is spastic weakness of the corresponding leg, with the appropriate alterations in the reflexes. There is also loss of the sense of position and of vibration sense in the parietic limb, with some sensory ataxia. Tactile, thermal, and painful sensibility are intact. On the side opposite to the lesion, motor functions are intact as are the sense of position and vibration sense, but there is loss or impairment of tactile, painful, and thermal sensibility. At the level of the lesion and on the same side, there may be a

zone of hyperæsthesia or of sensory impairment to all forms of sensation corresponding to the root actually compressed

Further, certain physical signs are peculiar to particular segmental levels of the cord, and are of importance in *segmental localisation of the lesion*

Motor Localisation —The list of muscles with their segmental innervation given in the table below indicates the muscles in which wasting and other signs of a lower motor lesion must be looked for at different segmental levels of compression

SEGMENTAL REPRESENTATION OF MUSCLES

C 4	Scaleni, trapezius levator anguli scapulae, diaphragm
C 5	Levator anguli scapulae, scaleni, supraspinatus rhomboids, infraspinatus teres minor, biceps brachialis anticus deltoid, supinator longus (brachio radialis) serratus magnus (s. anterior), pectoralis major (clavicular part)
C 6	Subscapularis pronators, teres major, latissimus dorsi, serratus magnus pectoralis major
C 7	Triceps, extensors of wrist and digits
C 8	Flexors of wrist and digits, small hand muscles
Th 1	Interossei and small hand muscles
Th 2 to 12	Intercostals, abdominal muscles
L 1	Quadratus lumborum
L 3	Sartorius adductors of hip, ilio psoas
L 4	Quadriceps extensor femoris, abductors of hip
L 5	Flexors of knee
S 1	Calf muscles
S 2	Clutei, peronei anterior tibial muscles small foot muscles
S 3, 4	Pelvic muscles

Sensory Localisation —Fig. 21 provides corresponding information for determining the segmental level from the sensory loss

Reflex Localisation —Tendon reflexes, the reflex centres of which lie in the compressed segment or segments, may be abolished or changed. The segmental representation of the main tendon reflexes is as follows: biceps jerk fifth cervical segment, supinator (brachio radialis) jerk fifth and sixth cervical segment, triceps jerk, sixth and seventh cervical segment, knee jerk, fourth lumbar segment, ankle jerk, first sacral segment

Lesions involving the grey matter of the fifth cervical segment may produce what is known as inversion of the supinator jerk. Thus this jerk is replaced by finger flexion. This sign is not infrequently seen in syringomyelia, traumatic lesions of the cord due to dislocations or fractures of the

cervical spine, and in spinal tumours at the fifth cervical level. Similarly, in lesions involving the first sacral segment, a hamstring jerk only may occur on tapping the tendo Achillis.

The Cervical Sympathetic.—The signs of paralysis of the cervical sympathetic may be associated with lesions involving the lowest cervical and first thoracic segments or their spinal nerve roots. These are pupillary myosis, enophthalmos, and a narrowing of the palpebral fissure. Also lesions of the cervical cord, if they interfere with the bulbospinal sympathetic fibres, will produce this symptom-complex.

Temperature disturbances are occasionally associated with cervical cord lesions. Of these hyperpyrexia is the commoner, but abnormally low temperatures (86°-90° F.) are very rarely seen.

Conus Medullaris and Cauda Equina.—The cauda equina includes all the spinal nerve roots below the second lumbar roots, and hence the motor and sensory symptoms resulting from compression of this structure will depend upon the particular roots involved. The motor symptoms will be of lower motor neurone type, that is, flaccid paralysis with atrophy. The knee and ankle jerks may be abolished. Sensory loss will be restricted to the area supplied by the lower four lumbar and all the sacral dorsal roots. Frequently only the sacral roots are compressed. When this is the case motor symptoms are confined to muscles below the knee. There may be loss of the ankle jerk and sensory loss over the sacral root areas, i.e., the perineum and posterior aspect of the leg with the sole of the foot. Fractional parts of this motor and sensory symptomatology occur when a smaller number of roots are involved. The sphincter disturbances corresponding to these various lesions consist in overflow incontinence of urine with incontinence of faeces.

In the case of the conus medullaris also, the motor symptoms are very like those resulting from lesions involving the cauda equina, in being of lower motor neurone type and of comparable distribution. The sensory loss also is much the same, but there may occasionally be dissociated anaesthesia. The great pain of root distribution, which may attend lesions of the cauda equina, is commonly absent in conus lesions.

We may appropriately refer here to the clinical picture characteristic of secondary carcinoma of the spine. There may be multiple deposits in the vertebrae, but the lumbar spine tends to be early and severely involved. The sequence of events is commonly as follows:—Some two or more years

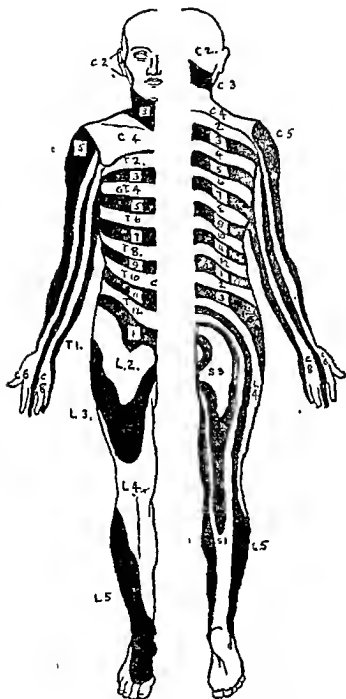


FIG. 21.—The Cutaneous Areas supplied by the Posterior Nerve Roots.

after the excision of a carcinoma of the breast the patient, while making some physical effort, experiences sudden intense pain in the back. These "alarm pains" as they have been called, recur at increasingly short intervals and may be present for some months before examination reveals any local or neurological signs. Finally, the signs of compression of the lumbar enlargement and lower end of the cord make their appearance. Death usually intervenes, from the presence of malignant disease elsewhere in the body, before paralysis becomes profound.

Diagnosis of Gradual Compression—The differential diagnosis of slowly developing spastic paraplegia may be attended with considerable difficulty. In the case of vertebral disease, the development of a localised tenderness or of local pain or again of deformity, will reveal the situation and nature of the lesion. But both in malignant disease and in spinal caries, root and cord compression may appear before deformity. In this case radiography may reveal what clinical examination of the spine fails to show. Rigidity of the spine is common in vertebral disease, but may also occur in the case of meningeal or nerve root tumours. In the case of compression from disease (tumours, meningitis) within the vertebral canal the presence of a great excess of protein in the cerebrospinal fluid (Froin's syndrome) may confirm the presence of a local block in the subarachnoid space. The persistence of root pains, though not a constant phenomenon, is often of great diagnostic and localising value. In meningeal and nerve root tumours the signs of root and cord compression are commonly unilateral at onset but bilateral in vertebral disease. It is usually impossible to differentiate extra medullary and intra medullary spinal tumours.

The differentiation of compression from other focal or diffuse cord lesions may also be difficult. In the so-called spinal form of disseminated sclerosis careful examination will usually reveal one or other of the following signs: slight nystagmus, pallor of one or both optic discs, or a pathological increase in the tendon jerks of the arms, while a careful case history will reveal the long past occurrence of transient blindness of one or both eyes, of diplopia, or of temporary ataxy of an arm. Further, cutaneous sensory loss is very exceptional in early disseminated sclerosis, the usual sensory change being a loss of vibration sense in the legs, with or without slight impairment of the sense of position in these limbs.

In a few cases of amyotrophic lateral sclerosis signs of lateral sclerosis (spastic paresis of the legs without sensory or

sphincter disturbance) may antedate the appearance of wasting in the hands. The patient is usually a middle aged man, there is no history of root or other pains, and the arm and jaw jerks may be extremely brisk. Wasting of the intrinsic muscles of one or both hands commonly appears within a year of the onset of spastic weakness of the legs.

The presence of spastic weakness of the legs with sensory changes showing a more or less distinct and a constant upper level, with reflex changes strictly confined to the regions below this level, and the characteristic changes in the cerebrospinal fluid, are essential to a diagnosis of spinal compression, but some cases remain without one or other of these signs, and diagnosis cannot be certain without an exploratory laminectomy. An additional diagnostic method is now available in the intrathecal injection through the atlanto occipital membrane of an oily solution of iodine, named lipiodol. This being opaque to the X rays and of considerable density, tends to sink in the theca until it encounters a block where its retention may be revealed by radiography. This method involves skilled procedure and should be reserved for those cases where it is absolutely essential for a differential or a localising diagnosis. An alternative procedure is to inject lipiodol by the lumbar route, the patient being on a tilting X ray table. The lipiodol then runs headwards to the lower limits of the obstructing lesion, where it may be radiographed.

2 SUDDEN COMPRESSION OF THE CORD

This is almost invariably the result of vertebral injuries, but may occasionally result from the sudden collapse of a vertebral column which is invaded by malignant disease. In the case of indirect violence the cervical spine is most commonly involved, fracture or fracture with dislocation occurring between axis and atlas, or between the fifth and sixth cervical vertebrae. Death commonly follows the first of these, but after the second every grade of spinal cord injury may be seen. Any violence which forcibly flexes the head on the neck such as falls from horses or diving into shallow water may produce fracture with dislocation between the fifth and sixth cervical vertebrae. It is important to remember that in such cases attention to the scalp wound may lead to a neglect to consider the possibility of vertebral injury.

The other situation in which the spine may be fractured is the dorso lumbar region. Falls from a height in which the individual drops standing on his feet, or strikes his back on

some projecting object, usually involve this region and produce severe crushing of the cord

Morbid Anatomy—In severe compression the cord is pulped at the level of injury, and the damaged tissue rapidly necroses and becomes diffuent. At the upper and lower limits of damage oedema and serous effusion with slight hæmorrhage are found. Later, there is a glial reaction with active phagocytosis at these points. If the subject survive long enough, ascending and descending degenerations are to be seen.

In the less severe lesions sustained in most cases of fracture-dislocation of the lower cervical spine, the cord is only momentarily compressed or nipped, and may with the partial return of the vertebrae to the normal be freed from permanent compression.

Symptomatology—Sudden compression, even when the cord is not completely crushed, frequently results in complete flaccid paraplegia with total sensory loss below the level of the lesion. There is also retention of urine and intense priapism. Bedsores develop with extreme rapidity over the sacrum. In high cervical lesions death may ensue from paralysis of the respiratory muscles, while with lower level lesions septic absorption from bedsores or from a bladder infected by catheterisation may also lead to a rapidly fatal issue.

When the structural damage is less severe, this stage of total interruption of conduction through the lesion is short and some return of power and of sensation occurs. In the case of the lower cervical spine atrophy and paralysis of varying degree and extent is found in the arms (corresponding to damage to the grey matter of the crushed segments), with a varying degree of spastic paresis and sensory loss in the lower limbs. In some cases recovery is almost complete, but many patients are left with severe residual disability. The more severe grades of paralysis following injuries of the cervical spine are readily recognised but the slighter grades may escape recognition. In these there is slight spastic paresis of the legs, with the appropriate changes in the reflexes and some spasticity of the arms with wasting of the hand muscles. After the first few weeks, sensory loss may be minimal or absent and the condition is apt to be diagnosed as amyotrophic lateral sclerosis. A history of sudden onset following a fall or injury involving the head or neck, the persistence of pains in the neck, shoulders or arms, limitation of movement of the neck, and inversion of the radial reflexes in the arms should make a correct diagnosis possible.

Total Transverse Lesions of the Cord—It will be mentioned that sudden transverse lesions of the cord, either traumatic or inflammatory (see "Myelitis," p 913), may for the time produce a complete interruption of conduction through the damaged segments, apart from anatomical solution of continuity. The clinical picture of such interruption consists of total flaccid paralysis and sensory loss below the level of the lesion, total abolition of the tendon reflexes and of the abdominal reflexes, and retention of urine. In respect of the plantar responses, the initial finding varies. There may be no plantar response, there may be a plantar flexion movement of the great toe, or there may be a feeble Babinski type of response. The anal and bulbo cavernosus reflexes are often preserved. The skin overlying the paralysed region is dry, and rapidly becomes shiny and tends to crack. Bedsores appear rapidly unless great care is taken to prevent their formation. There may be marked oedema of the feet and ankles, which are cold. The isolated portion of the spinal cord, therefore, shows no reflex activity of any kind except in respect of the two reflexes mentioned as sometimes retained.

If, with the exercise of great care infection of the bladder and the development of bedsores be prevented, this initial stage of *spinal shock* gives place in about the third week to a slowly developing phase of *spinal reflex activity*. The limbs remain paralysed and completely insensitive, but the flexion reflex which was described in the introductory chapter to this section (*vide* p 899) gradually emerges from shock. The receptive field of the reflex, that is, the area from which it can be elicited, spreads so as to include the whole sole and gradually during the course of weeks, spreads up the leg so as finally to include the skin of the whole limb and even the abdominal wall below the level of the lesion. Any stimulus within this extended region will evoke the appropriate reflex response. Further, stimulation of deep structures (tendons and muscles) also suffices to evoke the response. The response itself also progressively increases in extent and intensity. At first feeble dorsiflexion of the hallux and feeble contraction of the hamstrings alone occur, later, flexion at ankle, knee, and hip are added, and finally, with complete restoration of reflex activity, almost any strong stimulus to the limb evokes a powerful flexion spasm, including dorsiflexion of ankle and toes. This response is often bilateral and may be accompanied by powerful contraction of the abdominal muscles. When the last named occurs the bladder is compressed, the sphincters are reflexly relaxed, and urine is forced out of the bladder. Also, retention

gives place to periodical evacuation of urine. But in both circumstances the bladder is not fully emptied, some residual urine being retained. It is probable that the bladder wall never contracts reflexly with any force after spinal cord transection, and therefore true emptying of the bladder does not occur. The term "automatic micturition" which has been given to this periodical passage of urine is, therefore, not accurate, since the phenomenon described above is only a mutilated fragment of the complete act. The knee and ankle jerks may reappear.

With the passage of time the legs tend to go into the condition described earlier as that of paraplegia in flexion, and stimulation of the limb evokes, simultaneously, powerful bilateral flexion of the legs, the passage of urine, and an outburst of sweating over the paralysed parts of the body. This unphysiological combination of reflex reactions has been called the "mass reflex," and its presence indicates the gross disturbance which transection produces in the reflex activity of the isolated segments of the cord.

In the majority of cases the subject succumbs before the phase of spinal shock has been passed, and for the reasons which have been given. If he can be tided over this period, the tendency to the development of bedsores diminishes, the bladder does not require such frequent catheterisation and is not so readily infected and life may be prolonged for years, but no restoration of motor or sensory function is possible.

Treatment—In the case of spinal caries, immobilisation of the spine in the supine position for a period of from six to twelve months is imperative, even severe paraplegia may recover completely in these circumstances. There is obviously no effective treatment for cases of malignant disease of the spine, but severe pain may call for relief, which, seeing the inevitably fatal issue, may be given in the form of heroin or morphia if less potent agents fail. Deep X ray therapy may give considerable relief from pain. Meningeal and nerve root tumours of the customary benign type must be removed and if this be successfully done at a period before the development of marked sphincter paralysis, complete recovery of function and non recurrence of the tumour may usually be anticipated. In cases of uncertain diagnosis it must be remembered that removal of a tumour may mean recovery, while its non removal certainly means complete paralysis and death. This is also true where diagnosis rests between compression and intra medullary disease and whenever there is a reasonable possibility of a tumour being present and the segmental level

of the lesion can be ascertained laminectomy should be urged since the alternative is to leave the patient to his fate

In the case of sudden compression from fracture or fracture dislocation, where it is certain that the cord is not completely crushed, or where total crushing is improbable, a decompressive laminectomy may be performed if radiography reveals a narrowing of the vertebral canal. Crushes of the crura equina should always be treated by decompression in this way

When there are signs, either physiological or anatomical, of total division of the cord, treatment consists in protecting the patient from infection of the bladder when catheterisation is necessary, and in the prevention of bedsores. For the latter purpose the back must be washed with soap and water every four hours and the skin rubbed with spirit. The patient should be nursed on an air or water bed, and should from time to time be turned on to one or other side to prevent constant pressure on the tissues over the sacrum. Despite these precautions, rapidly deepening bedsores may develop and become infected. A septic discharging bedsore must first be cleansed by fomentation, and then treated by being plugged with gauze saturated in eusol or other antiseptic fluid. Later, red lotion, zinc oxide castor oil ointment or Friar's balsam may be employed. A urinary antiseptic mixture should be given.

SYRINGOMYELIA

Syringomyelia is a chronic progressive disease of the spinal cord, characterised by the presence of a cavity of varying length within the cord. The cavity arises in a rest of embryonic tissue in the region of the central canal. This undergoes proliferation during early life and breaks down at its centre with the formation of a cavity. The symptoms appear during early adult life, and are the result of compression of normal structures in the cord by the enlarging lesion.

Ætiology.—Both sexes are equally affected. There are said to be no *hereditary or familial factors*. Occasionally, however, symptoms may appear in childhood, and in some cases kypho scoliosis developing at this period has been the first sign of the malady. It may be accompanied by the presence of other structural abnormalities of congenital origin, such as spina bifida or deformities of the skull and bones. Hence the name "*status dysraphicus*" which has been applied to these conditions.

Morbid Anatomy.—The glial proliferation or gliomatosis of syringomyelia appears to originate in the neighbourhood

of the grey commissure of the cord. On inspection the cervical and less commonly the lumbar regions of the cord, may be irregularly enlarged, owing to the dimensions of the enclosed cavity at these levels. Serial sections through the cord reveal the presence of a central gelatinous mass of glial tissue enclosing a cavity, which varies in size from segment to segment and contains a fluid which may be clear and watery or glairy in consistence.

In some regions the cavity is large and its glial wall thin, in others a dense glial mass contains a narrow cavity. The process may extend from end to end of the cord, and sometimes passes upwards into the medulla. Here it has the appearance of one or more fissures radiating ventrally and laterally from the floor of the fourth ventricle and contained by walls of glial tissue.

Degenerative changes in both grey and white matter are present, due in part to compression and in part to actual invasion and destruction of the nervous elements by the proliferating glial tissue.

The lower cervical and upper thoracic segments are almost always the region in which the nervous tissue is most severely damaged, and are therefore the regions to involve ment of which most of the clinical manifestations of the disease are due.

Symptomatology—The nature and topography of the symptoms may be deduced from the situation of the lesion that has been described above. They may be classified as under: (1) Sensory changes due to compression of the sensory fibres subserving thermal and painful sensation, as these fibres pass from the posterior horn across by the grey commissure to the lateral column of the opposite half of the cord, these may be interrupted over a number of segments. (2) Atrophic paralysis of lower motor neurone type of a distribution corresponding to those segments in which the grey matter of the ventral horns is damaged. (3) Spastic weakness of the lower limbs due to compression of the pyramidal tracts, as *these traverse the severely compressed segments*. (4) Trophic and vasomotor symptoms.

Sensory Symptoms—From what has been said above it is clear that there is commonly a "dissociated sensory loss" in syringomyelia. The forms of sensation which travel by crossed paths, namely, temperature and pain sensibility, are lost, those which travel by an uncrossed path in the posterior column, namely, the sense of active and passive movement and certain aspects of tactile sensibility, remain intact. This dissociation

is not constant, and in some advanced cases all forms may be impaired. The topography of this peculiar sensory disturbance varies from case to case. The characteristic feature, however, is that there is both an upper and lower level of loss. The upper level may reach the limits of the cutaneous distribution of the fifth cervical nerve or some lower level, while inferiorly it may reach any of the thoracic segmental areas. It rarely extends below the thoracic region. It may be unilateral or bilateral, and when bilateral may be asymmetrical. Subjective sensory disturbances are relatively infrequent, and when present generally consist of pain referred to one or more of the segments in which there is sensory loss. A common result of the loss of pain sense in the hands is that the subject burns his fingers when holding hot objects, and is made aware of the burn only by the appearance of a blister. On the hands of such a patient the scars and recent ulcers of such injuries may be a conspicuous feature.

Muscular Atrophy—Wasting is most frequently seen in the small hand and forearm muscles. It may, however, be found in other regions, such as the scapular region, and in the case of lumbo-sacral involvement, in the lower limb. Like the sensory loss, it may be unilateral or bilateral and asymmetrical, the latter condition being more common. The wasting tends to reach a certain degree of intensity, and there to be arrested short of total loss of muscle fibre. In some muscles, however, it may become complete. Deformities of the hand are common, with severe wasting, claw hand being the usual type.

Spastic Paresis of the Legs—This is not a constant or an early feature, and does not usually become severe.

Trophic and Vasomotor Symptoms—Rarefaction of the bones of the upper limb and Charcot's osteoarthropathy in shoulder or elbow joints may be present. These lesions are particularly apt to occur in labouring men in whom the bones and joints are peculiarly exposed to strain. Extremely common is a condition of the hands in which they become red or cyanosed in colour and puffy in appearance and consistence, owing to a diffuse thickening of the subcutaneous tissues. Such a hand, when grasped, gives the examiner the impression of a soft boneless structure. This is the so-called 'succulent hand'. This state of the tissues and the particular liability to injury dependent upon the analgesia, lead to the presence of infected wounds and ulcers, of whitlows, and sometimes to necrosis of the terminal segments of the digits.

Cases with prominent deformities arising in this way were formerly spoken of as cases of Morvan's disease. It is

characteristic of lesions of the kind that they are painless throughout their course

Other symptoms sometimes met with are signs of paralysis of the cervical sympathetic (enophthalmos, myosis, narrowing of the palpebral fissure, and disturbance of sweat secretion over face and forequarter), when the last cervical and first thoracic segments are severely involved. Similarly the phenomenon of inversion of the supinator jerk, referred to in the section on "Compression of the Spinal Cord," may be met with (*vide p 901*)

Syringobulbia—The signs indicating spread of the lesion into the medulla are nystagmus (involvement of the posterior [medial] longitudinal bundle), hemiatrophy of the tongue (involvement of the hypoglossal nucleus) rarely facial paresis (involvement of the facial nucleus), unilateral paralysis or paresis of the palate, pharynx and larynx and sternomastoid (involvement of the vagus accessorius nuclear complex), or analgesia of a peripheral zone of the face (involvement of the spinal root of the trigeminal nerve). Of all these, hemiatrophy of the tongue, sensory loss on the face, and nystagmus are the most frequently encountered.

Skeletal Deformities—Kypho scoliosis is practically a constant phenomenon in syringomyelia and may reach an extreme degree of deformity. Other deformities are asymmetry of the skull and pea cavus, and occasionally spina bifida. A number of cases in which syringomyelia and acromegaly have been associated are on record.

Course—The progress of the disease is usually very gradual, and may be completely or partially arrested for a long period of years at any stage. Rarely, hemorrhage into the cavity or its sudden distension may lead to an acute increase in symptoms, and sometimes to severe paraplegia of the legs. Intense pain is apt to accompany these events. Death may ultimately ensue after many years from respiratory paralysis or from intercurrent affections.

Diagnosis—In the early stages this may be rendered difficult by the fact that muscular atrophy may precede sensory loss, or conversely, sensory loss of dissociated type may appear before there is any wasting. In either case, the presence of spinal and other deformities is of diagnostic value. In respect of the motor symptoms, the combination of wasting of the forearm and hand muscles, with signs of spastic weakness of the legs is common to both syringomyelia and amyotrophic lateral sclerosis. In the latter there is no sensory loss, the tendon jerks in the arms are exaggerated, there are no skeletal deformities, and the patient is commonly a middle aged man.

Intra medullary or *extra medullary* tumours of the cervical region of the cord may also produce a comparable motor picture. Here also skeletal deformity is absent, and there is sensory change, not dissociated in type and involving all the body below the level of the lesion. Progressive paraplegia with sphincter disturbance and root pains of constant distribution, and the absence of trophic and vasomotor symptoms, all serve to distinguish compression by meningeal or nerve root tumour or by pachymeningitis from syringomyelia.

Hæmatomyelia, in which the topography of the lesion is the same as that seen in syringomyelia, may present a comparable clinical picture, with the exceptions that trophic, vasomotor and skeletal signs are absent and that the onset is sudden in the former. Cervical rib, when it is manifested by the development of wasting of the muscles of one hand and by pain in the arm, may be mistaken for an early manifestation of syringomyelia. In the former, the signs remain unilateral and confined to the arm, there is little or no sensory loss of any kind, and the wasting is selective in incidence, in many cases being confined to opponens and abductor pollicis.

Treatment—The drugs usually employed are potassium iodide and mercury, the latter being given by inunction. X ray therapy to the region of the cervical spine has been extensively employed but with uncertain results. It may relieve pain in those cases where this is a distressing feature. In general, we may say that the malady is uninfluenced by any form of treatment and slowly progresses unchecked.

HÆMATOMYELIA

True hæmatomyelia is a rare condition. Commonly said to be traumatic in origin, the fact is that crushing injuries of the spinal cord produce softening but not massive hæmorrhage. Such hæmorrhage when it occurs is associated with abnormalities in the spinal vessels or with other forms of arterial disease, e.g., in syphilis. The symptoms consists in a sudden development of a paraplegia, usually cervical in level, with severe pain. Thereafter a more or less incomplete recovery process sets in.

ACUTE INFECTIVE MYELITIS

A rare malady characterised clinically by the acute development of paraplegia with a febrile reaction, and due to an infective inflammatory process in the spinal cord.

Ætiology.—Acute myelitis is a malady of comparatively

rare occurrence, affecting persons of all ages and both sexes indifferently. Very little is known either of the channel of access of the organisms responsible to the cord, or of the organisms which produce this result.

In some cases tuberculous or pyogenic osteomyelitis of the spine may by direct extension lead to infection and inflammation of the cord, in others no local focus of infection is present, and organisms must reach the cord either by perineural lymphatic channels or by the blood stream.

Morbid Anatomy.—The inflammatory process may be focal or diffuse. In the former case there may be a transverse lesion of the cord producing the clinical features of complete transection. In the latter, the lesion may be disseminated or may spread upwards from the original focus (ascending myelitis).

In the acute stage the affected regions of the cord are swollen, hyperæmic, and œdematous. Hæmorrhages may be present, or thrombosis of spinal vessels with associated softening (myelomalacia). Microscopically there is intense vascular engorgement with minute and larger hæmorrhages, intense cellular infiltration, and an active neuroglial reaction. The nerve cells show chromatolysis, and the axis cylinders are to be seen in every stage of degeneration. In old recovered cases a varying degree of parenchymatous degeneration with neuroglial sclerosis is seen.

Symptomatology.—The malady develops with fever and pains in the back and lower limbs and a rapid onset of severe paraplegia. In transverse myelitis the picture of total transection of the cord may be established in a few hours. The cerebrospinal fluid may show little or no abnormality when the meninges are not seriously involved, but an excess of cells, mainly polymorphonuclear leucocytes, is the rule, together with an increased protein content. No organisms may be found either on direct examination or on culture, but occasionally pneumococci or other pyogenic organisms may be present in the fluid. Their discovery in sections of the cord is exceptional.

While in most cases, a picture like that of complete transection of the spinal cord is seen, a less severe paraplegia may occur. In the latter case, complete recovery may ensue, but after total flaccid paraplegia only imperfect restoration can be expected, and if the patient survive the first few weeks of the illness, he remains with a residual spastic paraplegia of severe degree.

In ascending myelitis, the respiratory muscles become successively paralysed and death commonly ensues within a few days of onset.

The Cerebrospinal Fluid may show the Froin syndrome - (see p 897) when the meninges are involved, otherwise it may be normal

Diagnosis—The possibility of syphilitic meningo myelitis, which is more frequently seen, has to be considered, and when this is present the cerebrospinal fluid will show an increased cellular and protein content, a positive Wassermann reaction and the colloidal gold reaction described on p 848. In elderly persons, spinal thrombosis may be responsible for a sudden complete paraplegia. In this case the cerebrospinal fluid remains normal.

Treatment—The lesion is established so rapidly that little but symptomatic measures can be carried out. It is of the utmost importance to protect the bladder from infection should catheterisation be necessary, and to prevent the development of bedsores. Therapeutic lumbar puncture may conceivably be of value, and the administration of massive doses of hexamine may be tried.

SUBACUTE COMBINED DEGENERATION OF THE SPINAL CORD

This is a malady of middle aged and elderly persons of both sexes and presents the clinical picture of a progressive lesion of the posterior and lateral columns of the spinal cord. It is associated with pernicious anemia. Sometimes the cord lesion precedes the blood change and dominates the clinical picture but in other cases the symptoms of a nervous lesion may occur during the course of a fully developed pernicious anemia.

Ætiology—The disease is uncommon before the fourth decade of life. Its ætiology is that of pernicious anemia to which the reader is referred (p 347).

Morbid Anatomy—The cord is normal in appearance on the surface, but on section the posterior and lateral white columns present the translucent appearance of degeneration. The foci of this change lie in the centre of the posterior column and deep in the posterior part of the lateral column. With the development of the disease they enlarge progressively until they reach the surface of the cord, and include all the white matter except that immediately surrounding the grey matter and containing the short proprio spinal fibres.

Microscopically, demyelination and destruction of axis cylinders with the presence of vacuolisation, where fibres have been completely destroyed, constitute the essential lesion.

There is strikingly little neuroglial or vascular reaction a feature which distinguishes this disease from all other spinal cord diseases. The process is most intense in the thoracic segments of the cord, but extends up as far as the brain stem. The cell bodies of degenerated nerve fibres show secondary changes. In some cases considerable peripheral nerve degeneration of the limb nerves may be seen, even greater in intensity than the cord changes.

Symptomatology—The onset of nervous symptoms may be preceded by periodical gastro intestinal disturbances slight fever, diarrhoea alternating with constipation, pain in the hypochondrium, and occasionally jaundice. Attacks of this kind sometimes punctuate the course of the developed disease. The onset is usually slowly progressive, and the initial symptoms consist of subjective sensory disturbances in the extremities especially in the feet. The patient complains of feelings of wetness, coldness, numbness, of tingling, and of "pins and needles." Similar, but less distressing, paresthesia may be present in the fingers, which begin to lose fineness of co-ordinated movement with their appearance. Pain below the costal margin of "girdle" character is common, and may become more marked during the febrile reactions associated with the occasional bouts of diarrhoea.

Examination at this stage reveals in many patients the peculiar colour of complexion and the shiny atrophic tongue of pernicious anaemia. The blood may present changes identical with those of the various degrees of pernicious anaemia, but in many early cases very little deviation from normal may be found, although ultimately severe anaemia usually develops. It has been mentioned that achlorhydria is extremely common in subacute combined degeneration, but it is not yet possible to say that it is an absolutely constant finding. The spinal cord symptoms vary according to whether the posterior or lateral white columns are predominantly affected. Usually the former are earlier involved but by the time definite symptoms appear the presence of a Babinski plantar response indicates lateral column affection. Two clinical types may be recognised. (1) *Flaccid Type*—In this posterior column symptoms may predominate, namely, weakness and flaccidity of the lower limb muscles with some degree of sensory ataxia and of Rombergism, absence of the tendon jerks, and impairment of cutaneous sensibility of minor degree over the distal parts of the limbs. The calf and plantar muscles are almost invariably tender to pressure, a clinical indication of the peripheral nerve degeneration which is always found

on microscopic examination. It is possible that further observation will indicate that peripheral neuritis plays a more prominent part in some cases of the malady than has hitherto been thought. Indeed, in some instances the physical signs are—at least in the early stages of the malady—quite indistinguishable from those of a peripheral neuritis. Sooner or later, however, the appearance of a Babinski plantar response indicates the presence of spinal cord changes, while the associated blood changes help to distinguish the case from an ordinary one of peripheral neuritis.

(u) *Spastic Type*—In other cases lateral column signs predominate, namely, spastic weakness of the legs with increased tendon jerks, clonus and the Babinski plantar response. As the paralysis increases painful and powerful flexor spasms make their appearance and the final condition is one of paraplegia in flexion. Sometimes this symptom complex gives place to that described above as the posterior columns are progressively involved. Variations of this kind, from case to case and from stage to stage in a given case, indicate the development of the process in the posterior and lateral columns of the cord, and so far from rendering diagnosis difficult constitute one of the most characteristic features of the malady.

As the disease advances, motor weakness and sensory loss increase, the patient becomes bedridden and if anæmia be present the characteristic signs thereof are added to those of the cord lesion. As a rule the functions of the cranial nerves are unaffected. Slight oedema of the optic disc is occasionally seen, and retinal hæmorrhages may be a terminal phenomenon. If a severe grade of anæmia accompanies these nervous symptoms, mental disorder may make its appearance. Memory is defective, and the patient becomes irritable and confused. In extreme cases the patient may be delusional and difficult to handle. The cerebrospinal fluid is usually unaltered.

Prognosis—It is not possible in the present advancing state of knowledge to make a definite statement as to prognosis. In many cases of pernicious anæmia in which appropriate treatment has restored the blood to an approximately normal condition, the signs and symptoms of a cord lesion have undergone no corresponding degree of improvement, and may even have increased in severity until the patient becomes paraplegic. On the other hand, in early cases, and especially those in whom the signs are those referred to above as resembling a peripheral neuritis, remarkable improvements may be achieved. The

severely spastic cases, as might be expected, respond much less favourably and frequently not at all. The final stage of the disease is then one of profound cachexia with motor, sensory, and sphincter paralysis, and the various complications which arise from this state however produced.

Diagnosis—In typical cases the clinical picture is so characteristic as to be readily recognisable. The patient is over forty years of age, yellowish in colour with a malar flush, pale mucosæ and a shiny tongue, though these signs are not constantly present. The signs of a postero-lateral degeneration of the cord complete the picture. When anæmia is absent and the picture of spastic paresis of the legs is present, disseminated sclerosis can generally be excluded by the age of the patient, the presence of cutaneous sensory loss, and absence in the history of the visual symptoms which often occur early in the course of disseminated sclerosis. Moreover, the prominence of paræsthesiæ in subacute combined degeneration is rarely a feature of disseminated sclerosis. With absent tendon jerks and flaccidity of the lower limb muscles tabes may be excluded by the absence of the tabetic pupillary abnormalities, of the sensory loss on face and trunk, and by the presence of muscular tenderness in place of the muscular insensitiveness to pain of tabes. The cerebrospinal fluid also renders the recognition of tabes possible. A slowly developing polyneuritis may more closely resemble an early subacute combined degeneration with posterior column involvement predominating than either of these maladies, and in the absence of an extensor or Babinski type of plantar response, differentiation may for a time be difficult until the progress of the malady reveals signs of lateral column degeneration.

Treatment—Whether the blood picture be certainly that of pernicious anæmia or not, the treatment of subacute combined degeneration of the cord is that of pernicious anæmia, *but more persistently and more intensively carried out*. The improvement in the nervous symptoms must be the sole guide in this respect, and no precise rules can be laid down. Intra-muscular injections of a liver extract may be necessary daily for three or four weeks before a progressive improvement sets in.

As has been said, the spastic type of subacute combined degeneration frequently makes no response whatever to treatment, but the flaccid type, especially in its early stages, will often improve in a remarkable manner if treatment be continued over a long period, and "maintenance" doses of a liver extract be given from time to time.

Details of treatment are given under the heading of pernicious anaemia (*vide* p 352)

If an anæmic patient respond to this treatment, the ataxy of gait and the weakness may be dealt with by carefully graded re education exercises and by massage In the terminal stages of the malady, sleeplessness, pain, flexor spasms in the legs, cystitis, and bedsores may all call for appropriate symptomatic measures

THE HEREDO FAMILIAL ATAXIES

This group of associated maladies includes several clinical types of motor disorder, which depend for their respective features upon a varying incidence of degenerative changes in the parenchymatous elements in cerebellum, brain stem, and cord As the title of the group indicates, hereditary and familial factors are the rule

Ætiology.—Direct or indirect inheritance is present in most instances, and several members of a family may be affected, both sexes being equally liable The symptoms commonly make their appearance during childhood Beyond these simple facts of observation nothing is known of their causation, but it is probable that a developmental defect is responsible

Morbid Anatomy—Usually, there is no microscopic abnormality of the nervous system The essential lesion is a primary neurone degeneration, with an associated secondary neuroglial reaction In the spinal cord, the posterior column fibres and the two spino-cerebellar tracts on the afferent side, and the pyramidal tract on the efferent, are the neurone systems most commonly affected In the brain, cerebellar neurones, both intrinsic and projection systems, cortico spinal fibres, and retinal neurones are the systems usually involved Not all these systems are involved in each type Thus, in Friedreich's ataxy, the incidence of the lesion is in the posterior and lateral columns of the cord, while in certain forms of cerebellar ataxy, cerebellar neurones alone present pathological changes

The following clinical types are described —

FRIEDREICH'S ATAXY—A disease developing slowly during childhood, frequently affecting more than one member of a generation and characterised by the signs of progressive degeneration of posterior column, pyramidal and spino cerebellar fibres, and by certain skeletal deformities

Ætiology—It commonly makes its appearance during the

second five years of life, but may not do so until adult life is reached. It tends to develop progressively until the subject is disabled, but its course may be arrested in the early stages before gross disability is produced. While the malady is commonly reported in generations preceding the one which comes under observation, single cases occurring in a stock otherwise free from all trace of nervous disease may occur.

Morbid Anatomy—Degeneration of the exogenous fibres of the posterior columns and of pyramidal and spino-cerebellar fibres with resulting sclerosis of the posterior and lateral columns are found. There may also be degenerative changes in the cells of Clarke's column (nucleus thoracicus).

Symptomatology—The symptoms of the disease are the natural result of a lesion of the fibre systems named above. In the legs are found the characteristic signs of postero-lateral cord degeneration, namely, weakness and flaccidity of the musculature, absence of the tendon reflexes, the extensor type of plantar response, and impairment of the sense of position with a corresponding degree of sensory ataxy.

In the arms, signs referable to disturbance of cerebellar function predominate, namely, tremor and unsteadiness of movement.

The arms and head show fine jerky movements when the muscles which innervate the limbs and neck are in action. Similarly, the facial and articulatory musculature may be affected with the production of facial twitching and disorder of articulation. A fine nystagmus is the rule.

All these symptoms develop insidiously. At first the child becomes unsteady on its feet, tends to stumble and fall and to have difficulty in changing position. In some cases the child has never been normally nimbly on its feet from early childhood. Later, the gait becomes markedly unsteady and the arms also show disorder of movement.

In addition to these indications of nervous disorder, certain skeletal deformities are the rule. Kyphoscoliosis of the thoracic spine and pes cavus. A rare symptom is optic atrophy with visual defect. Other congenital anomalies have been recorded such as congenital morbus cordis.

The course of the disease is usually very slowly progressive, although, as has been stated, arrest may occur at any stage. Death usually results from intercurrent maladies after the patient has become disabled and bedridden.

Treatment—The course of the malady is not materially influenced by any mode of treatment, but its progress may be delayed and the final stage of complete disability may

sometimes be put off by careful massage and remedial exercises

HEREDITARY CEREBELLAR ATAXY — This comparatively rare malady develops somewhat later in life than Friedreich's ataxy, occasionally in a family one member of which presents the latter disease, and resembles it pathologically and clinically in certain respects. Thus, there is degeneration of the spino-cerebellar and pyramidal fibre systems, as in Friedreich's ataxy, but also degeneration of neurones within the cerebellum. Clinically, the same signs of cerebellar disturbance are seen namely, nystagmus, articulatory disorder, tremor and ataxy, and in the lower limbs the phenomena of spastic weakness with their appropriate reflex alterations. Primary optic atrophy may occur.

CEREBELLAR ATROPHY — There are two forms of this primary cerebellar degeneration (1) cortical atrophy, and (2) atrophy of the white matter (the so called olivo-ponto-cerebellar atrophy).

Clinically, these are usually indistinguishable, and consist of a gradually increasing cerebellar ataxy involving the limbs and the musculature of articulation. Nystagmus may be absent. The patient is commonly a middle aged or elderly adult. The malady is slowly progressive and does not respond to treatment.

PROGRESSIVE MUSCULAR ATROPHY

General Considerations on Muscular Wasting — Muscular atrophy may result from disease primarily affecting the muscle fibre itself, or from disease of the motor neurone innervating it. In the differential diagnosis of the various clinical conditions which present muscular wasting the following factors are of importance (1) the mode of development and the distribution of wasting, (2) the presence or absence of certain peculiarities in the wasting muscle (fibrillation, tenderness, changes in direct and electrical excitability), (3) the presence or absence of signs of co-existing disease of the nervous system, and (4) the presence or absence of heredo-familial factors.

Cases of muscular atrophy fall into four main groups: (a) primary muscular dystrophy (myopathy) and certain allied conditions, (b) progressive muscular atrophy of spinal origin, (c) muscular atrophy secondary to paralysis of nervous origin, (d) atrophy of muscles following arthritis.

The differential criteria given above may now be considered in detail.

1 *Mode of Development and Distribution* — Speaking generally, the wasting of muscular dystrophy and of progressive muscular atrophy are very slowly progressive, the weakness being a result of the wasting. In post-paralytic atrophy weakness precedes wasting, and may be sudden in onset, while the wasting is more gradual. Bilateral symmetry of wasting is characteristic of muscular dystrophy. In progressive muscular atrophy the wasting, although bilateral and often symmetrical in incidence, is rarely symmetrical in degree, since wasting appears in one limb earlier than in its fellow, and remains more advanced in the earlier affected muscles. When wasting of the intrinsic muscles of one hand remains unilateral for more than a year, the presence of a cervical rib may be suspected. Of equal significance is the incidence of the wasting throughout the musculature generally. Thus, in muscular dystrophy the muscles of the limb girdle and the proximal limb segment are predominantly and often exclusively affected while in progressive muscular atrophy wasting commonly begins in the distal limb muscles and remains most intense in these. Again, in muscular dystrophy the face muscles are often affected but those of deglutition, respiration and phonation escape. The reverse is the rule in progressive muscular atrophy.

In arthritis the muscles affected are those proximal to the joint, and particularly the joint extensors, *e.g.*, the vasti in arthritis of the knee joint.

2 *Features of the Wasting Muscles* — The irregular clonic twitchings of small muscle fibre bundles known as fibrillation are a prominent feature in progressive muscular atrophy, inconstant and slight in peroneal muscular atrophy and post paralytic atrophy, and absent in muscular dystrophy. In muscular dystrophy and progressive muscular atrophy the wasted muscles are painless on pressure, in wasting secondary to a lesion of a peripheral motor nerve they are commonly extremely tender to pressure while wasting is in progress. In muscular dystrophy the mechanical and electrical excitability of the muscles wane progressively and finally disappear, without the latter undergoing any qualitative change. In progressive muscular atrophy and in post paralytic wasting the mechanical excitability is increased and at a certain stage of wasting the reaction of degeneration may be present. In muscular dystrophy alone, the association of wasted with enlarged muscles is seen, the enlargement (pseudo hypertrophy) being due to fatty and fibrous infiltration of the muscle.

In two muscular diseases, dystrophia myotonica and

Thomsen's disease, a condition of myotonus or delayed relaxation is seen

3 *Signs of Nervous Disease*—Apart from an inevitable disappearance of tendon reflexes in wasted muscles there are no signs of nervous system involvement in muscular dystrophy, but such signs are found in progressive muscular atrophy and in post paralytic atrophy

4 *Age and Heredo Familial Factors*—Muscular dystrophy commonly begins in infancy, childhood, or adolescence. Progressive muscular atrophy is a disease of adult life. In the latter heredo familial factors are absent, but are constant in muscular dystrophy.

MOTOR NEURONE DISEASE

Progressive Muscular Atrophy, Chronic Bulbar Palsy, and Amyotrophic Lateral Sclerosis—Under these headings are described a single pathological process consisting in a primary degeneration of motor cells of the anterior horns of the cord, or of certain cranial nerve nuclei, and also in a degeneration of the lateral white columns of the spinal cord. The clinical picture varies according to the incidence of the motor cell degeneration, and also according to the relative degree of lateral column degeneration. In some cases the latter may not be evident clinically, while in others it dominates the clinical picture. Three main clinical types of the malady are described, but mixed types occur.

Etiology.—Rarely the disease may develop in the second decade of life, but the greatest frequency of case incidence is in the fourth decade. Males are more frequently affected than females, and this predominance increases with the age of onset. Its causation is quite obscure, and as is common in such circumstances, trauma is sometimes invoked as a causative factor, but without conclusive evidence. A comparable clinical picture is sometimes produced by syphilis, but syphilitic amyotrophy runs a somewhat different course, and is generally distinguishable both on clinical and serological grounds.

Morbid Anatomy—There are no striking macroscopical abnormalities in brain or spinal cord. The latter, seen in a section stained by the Weigert method, shows pallor of the lateral columns, particularly of the pyramidal tracts, and some change of this kind is seen even in cases which during life, presented no clear signs of pyramidal tract involvement.

By the Nissl method the motor nerve cells in the affected

regions are found to be diminished in number, the remaining cells being shrunken and altered in form and appearance. A slight degree of secondary neuroglial proliferation may be seen. Similar changes are found in the cranial nerve nuclei when the incidence is bulbar, while the Betz cells of the cerebral motor cortex may also be involved. The wasted muscles show all degrees of muscle fibre atrophy.

Symptoms—When the symptoms are referable, wholly or almost so, to degeneration of cells in the cervical segments of the cord, we speak of *progressive muscular atrophy*, when there are signs of an associated lateral column sclerosis we speak of *amyotrophic lateral sclerosis*, while in the case of a bulbar incidence of the nerve cell degeneration we speak of *chronic bulbar palsy*. This differentiation of the malady into three clinical types is artificial since a given case may present signs of all three, and this in varying proportion. In simple progressive muscular atrophy, so called, wasting usually makes its first appearance in the intrinsic muscles of one hand. This wasting is sometimes preceded by transient local aching pains and by parasthesiæ. The wasting may advance slowly up the limb, involving successively the shoulder girdle and scapular muscles including the lower half of the trapezius, the rhomboids, serratus magnus (S. anterior) and latissimus dorsi, and finally the neck muscles, including the sterno-mastoid, and the muscles of respiration. Weakness follows wasting and is in proportion to the degree of the latter.

The wasting muscles fibrillate freely, and their mechanical irritability ("tap contraction") is greatly increased and the reaction of degeneration may be present. The interval between the involvement of the two arms is generally a matter of several months but usually less than one year. The progress of the disease varies from case to case. The wasting may become arrested before the region of the shoulder girdle is invaded or, on the other hand, progress may be rapid and involvement of the neck and respiratory muscles may result in death within two years from the apparent onset of the malady. The degree and extent of the fibrillation generally gives some indication as to which of these two courses the malady is likely to run in a given case, free and widespread fibrillation, involving muscles not yet wasting, being of bad prognosis.

Chronic Bulbar Palsy.—This is the expression of a degeneration of the motor cranial nerve nuclei identical with that which may occur in the cervical region of the spinal cord. It is seen more frequently in males during the fourth and fifth decades of life. From the topography of the paralysis it is

often spoken of as "labio linguo laryngeal" or "labio linguo pharyngeal" palsy. The onset and progress are slow. The tongue is earliest and most severely affected. An indistinctness and laboured quality of the articulation is the first symptom, and may at the onset appear only on fatigue. Later the mobility of the tongue and lips becomes deficient, the tongue shrinks, becomes wrinkled, and fibrillates freely. Later, the laryngeal and suprahoid muscles and those of the soft palate are involved. The articulation becomes unintelligible and the voice weak and nasal in quality. Weakness of the lips and of the soft palate allow dribbling and regurgitation of fluids through the nose, and when the pharyngeal muscles are affected deglutition becomes difficult. In these circumstances particles of food are apt to enter the glottis, with the production of an aspiration pneumonia and death. This symptom complex may exist alone or be associated with the wasting of the limbs already described, the bulbar symptoms may usher in the disease or be a late complication.

Amyotrophic Lateral Sclerosis—One or both of the above clinical pictures may be associated with signs of sclerosis of the lateral white columns of the cord and of pyramidal fibres in the brain stem. These signs predominate in the lower limbs, which may become spastic, with increased tendon jerks, clonus, and a Babinski type of plantar response. The most common clinical form of the disease is that in which wasting of the upper limbs and spastic paresis of the lower limbs are combined. Either group of symptoms may usher in the malady. It is probable that most cases of so called primary lateral sclerosis are examples of this disease, in which lateral sclerosis antedates progressive muscular atrophy in the arms. Although wasting and fibrillation predominate in the arms, signs of lateral sclerosis involving the upper limb musculature in its consequences are seen in increased tendon jerks and increased mechanical irritability. The brisk jaw jerk so frequently seen in amyotrophic lateral sclerosis is another sign of pyramidal tract sclerosis.

Unlike what is found in certain other diseases in which the pyramidal tracts are the seat of change, the abdominal reflexes are not abolished early in amyotrophic lateral sclerosis.

Most difficult of diagnosis are those cases of progressive muscular atrophy with bulbar symptoms in which wasting of the lip, tongue, laryngeal and pharyngeal muscles is minimal, but phenomena of impaired upper motor neurone function predominate. Here the tongue is small and spastic, there is a tendency to emotional overaction of the face musculature, and

wasting in the upper limbs is slight. Such cases somewhat resemble the condition known as pseudo bulbar palsy, but the gradual onset and the clinical course with ultimate development of muscular wasting generally serve to exclude the latter.

Prognosis—In all except a few cases of the cervical cord variety, where arrest may occur, the disease steadily progresses, and ultimately proves fatal from pulmonary complications within three years from onset.

Treatment—There is no treatment which materially influences the course of the disease in any of its clinical varieties. Strychnine and the use of electrical stimulation of the affected muscles are useless, and indeed the latter may be harmful and there is no justification for its use. The avoidance of fatigue and all forms of stress and the maintenance of the general health are all that can be profitably attempted. The administration of vitamins E and B₁ for which extravagant claims have been made, has now been shown to be of no value in either motor neurone disease or muscular dystrophy. In bulbar palsy the patient has least difficulty with semi-solid food. Even in cases of syphilitic amyotrophy arrest of the progress of the wasting is generally the best that can be hoped for. Circumstances often make the assumption of the passive role in treatment thus indicated very difficult to maintain but it must be remembered that the adoption of neurotrophic measures such for example as electrical stimulation, does little but exhaust the patient.

PROGRESSIVE SPINAL MUSCULAR ATROPHY OF CHILDREN (Werdnig Hoffmann)—The aetiology of this relatively uncommon disease is unknown. It may occur in several members of a generation and both sexes are equally affected. It develops from birth or during the first six months of life.

Symptoms—The apparently healthy infant begins to lose power the trunk and proximal limb muscles being most severely affected. The reflexes are abolished, and electrical excitability of the muscles disappears. The sphincters are unaffected and there is no sensory disturbance or mental deterioration.

Death takes place within from three to five years. The lesion is an atrophy of the ventral horn cells and of the ventral nerve roots. The malady is uninfluenced by treatment.

PERONEAL MUSCULAR ATROPHY

(*Neuritic, or Charcot Marie Tooth Type*)

This disease is a form of slowly progressive muscular wasting of characteristic distribution. It is both familial and hereditary.

and makes its appearance in one of the first three decades of life, most commonly towards the end of childhood. Males are more frequently affected than females. It may first become manifest after an acute specific fever. Its ætiology is unknown.

Symptoms—Wasting first develops in the plantar muscles and then in the peronei, long extensors of the toes and calf muscles, later the muscles of the lower third of the thigh are affected. When the malady has been present for some years, wasting may make its appearance in the small hand muscles, ultimately both feet and hands become deformed. The wasting first invades the distal part of a muscle and later extends to its proximal portion. In this way, when the lower third of the thigh is wasted, the limb above the knee assumes the form of an inverted Indian club.

The wasting is frequently, but not constantly bilaterally symmetrical. The progress is so extremely slow that the subject may reach middle age before being seriously disabled. Fibrillation in the affected muscles may be seen, but is never marked.

The ankle jerks disappear as the calf muscles become involved, and later the knee jerks also disappear. There may be impairment of all forms of sensation over the wasted territory of the limb.

The disease does not shorten life and is not amenable to treatment, though the foot drop may call for mechanical support.

Morbid Anatomy—There is degeneration of the posterior white columns of the cord and also of anterior horn cells, the anterior nerve roots are shrunken and the branches of the peroneal nerve may show some interstitial neuritis.

MUSCULAR DYSTROPHY

(*Myopathy*)

Under this heading, we deal with a condition in which the skeletal muscles from congenital defect and progressive pathological change undergo atrophy. There is no associated lesion of the nervous system, and the disease is a primary one of the muscles themselves.

The ætiology is unknown, but may be of the nature of a qualitative defect in the embryonic tissue in which differentiated muscle fibres arise. It commonly occurs in several generations of a family and in the members of one generation. The malady may be transmitted by either sex and may occur in either

The pseudo hypertrophic variety predominates in males but the other varieties are more equally distributed between the sexes

Morbid Anatomy.—The muscle fibres are diminished in number and the interstitial tissue is increased in some muscles to such a degree that little or no contractile tissue remains. In the enlarged muscles fat globules are deposited in the fibrous tissue. Microscopically, the muscle fibres are shrunken, vacuolated, and altered in form, and their nuclei are increased in number.

Symptomatology.—The malady develops during infancy or childhood. It is slowly progressive, and although in the pseudo hypertrophic form some of the muscles are enlarged, the general progress is towards wasting of the affected muscles. The initial symptoms vary according to the clinical variety of the disease present. In many cases the child has never been normally nimble on its feet, and may have learned to walk and stand unduly late. Attention is called to the condition by the child's waddling gait, its tendency to fall, with a resulting difficulty in regaining the erect posture. In these circumstances the child rolls over on to his face, gets on to hands and knees, and then proceeds to climb up its legs by moving the hands alternately upwards on the limbs. Weakness of the hip extensors and contracture of the flexors lead to the adoption of an extreme lordosis, and weakness of the shoulder girdle muscles to winging of the scapulae.

Certain muscles are constantly affected. These are the lower part of trapezius and of pectoralis major, latissimus dorsi, serratus magnus (S. anterior), biceps and triceps, and in the lower limbs the adductors and hamstrings. When pseudo hypertrophy is present it involves erector spinae, the masseters, deltoid, spinati, sometimes biceps and triceps, and in the lower limbs the calf muscles, vasti, and glutei. Both wasted and enlarged muscles are weak, and the weakness is in proportion to the degree of atrophy of contractile tissue. The mechanical and electrical excitability of the affected muscles progressively wane and disappear, the electrical excitability undergoing no qualitative change such as the reaction of degeneration. Fibrillation does not occur. Ultimately, kypho scoliosis and contracture and deformity of the legs develop in the pseudo hypertrophic form of the disease. The tendon jerks become enfeebled and disappear as the relevant muscles waste. There is no sphincter defect and no sensory change. The following clinical varieties are recognised, but mixed forms are common.

PSEUDO-HYPERTROPHIC TYPE.—This is usually seen in males, is the commonest type, and develops during the first decade of life. The subjects do not reach adult life, becoming bedridden within a few years of onset and succumbing to some intercurrent disease, generally to pulmonary or intestinal infections. A waddling gait and enlargement of the calves may first attract attention to the child. The topography of wasting and pseudo-hypertrophy have already been stated.

SCAPULO-HUMERAL (ERN'S) TYPE.—This occurs in children and adolescents of either sex. It is more slowly disabling than the pseudo-hypertrophic variety, and the patients reach adult life. Weakness of the shoulder and then of the pelvic girdle muscles, with winging of the scapulae and lordosis and with wasting of the muscles concerned, are the features of this variety. Occasionally some enlargement of muscles is seen.

FACIO-SCAPULO-HUMERAL (LANDOUZY-DEJERINE) TYPE.—This resembles the preceding type, but in addition there is marked weakness of the facial musculature, with thickening and eversion of the lips. The eyelids cannot be closed nor the teeth covered.

DISTAL OR SIMPLE ATROPHIC TYPE.—This relatively rare type differs from those described above in that the incidence is in the distal limb muscles mainly, the facial muscles being affected later.

In all forms the ocular, lingual, laryngeal, and pharyngeal muscles are intact.

Diagnosis.—The factors governing differential diagnosis have been stated in the chapter dealing with "Progressive Muscular Atrophy" (p. 922).

Prognosis.—Recovery is unknown in any form of myopathy. In general it may be stated that the earlier in life the condition appears the more rapidly does it progress. The usual termination is from some pulmonary complication. In the pseudo-hypertrophic type the patient does not reach adult life, becoming bedridden and dying within five or six years of the onset. In the other types, progress is much more gradual and adult life may be reached.

Treatment.—From what has been said above, it is clear that no material influence is exerted on the malady by any form of treatment. Attention may most profitably be directed to retarding the development of contracture and deformity by means of massage and of such active exercises as the patient may be capable.

MYOTONIA CONGENITA (*Amyotonia Congenita*)

A rare disease of infancy, thought by some authorities to be identical with the simple atrophic variety of muscular dystrophy, but differing from this in that there is a tendency to gradual and partial recovery. It is undoubtedly a familial and possibly an hereditary malady, certainly closely allied to myopathy. The new born child has small and extremely soft muscles, which render possible an abnormal range of passive mobility of the limbs. There is no wasting and no associated signs of nervous lesion.

The child is not able to sit up or to hold its head erect until the second year of life, and may never be able to stand or walk. Occasionally, however, the capacity to do this may develop. The malady is not amenable to treatment.

MYOTONIA CONGENITA (*Thomsen's Disease*)

A very rare heredo-familial disease of obscure nature and origin characterised by a peculiar tonic spasm and delayed relaxation of the muscles on voluntary effort. The only discoverable lesion is an enlargement of the muscle fibres which are poorly striated. It develops during childhood, and the myotonia is always maximal on resuming activity after rest. There is not much weakness and sometimes the muscles may be enlarged assuming herculean proportions. All the skeletal muscles may be affected. Its progress is extremely slow and there may be some degree of associated mental impairment. It is not amenable to treatment.

MYOTONIA ATROPHICA (*Dystrophia Myotonica*)

A rare heredo-familial disease of unknown ætiology, developing during early adult life and occurring usually in males. It is characterised by atrophy of the facial muscles of sterno-mastoid of the forearm, hand and leg muscles, and also by myotonia, which is best and most constantly seen in the facial and tongue muscles, in the flexors of the forearm and in the calf muscles. Percussion or electrical stimulation of the myotonic muscles evokes a slow focalised contraction and delayed relaxation of the muscle fibres. Voluntary contraction is also followed by the same delayed relaxation. The patient has a myopathic facies, with considerable weakness of the facial musculature. Associated with these symptoms are mental deterioration, premature baldness, cataract, and atrophy

of the testicles. There is usually a history of presenile cataract in the generation immediately preceding the myotonic generation, and of senile cataract in the second generation. The myotonic generation, therefore, is the third abnormal generation in the family. A myotonic individual has, however, been known to become the father of a healthy child. It is clear from the wide range of symptoms that something more than a purely muscular disease is in question, and it is probable that we are dealing with a degenerative disease, developing over more than one generation and involving other structures than the musculature. Of its morbid anatomy little is known. Quinine in 5-gr. doses twice or thrice daily reduces the myotonia appreciably.

FAMILY PERIODIC PARALYSIS

This is a rare heredo-familial malady developing in childhood or adolescence, and characterised by attacks of paralysis affecting mainly the thoracic and proximal limb muscles. These often come on during the night or during periods of rest, and reach a maximum within a few hours, passing off again after a similar interval. As weakness develops, the tendon reflexes and the electrical excitability of the muscles wane and disappear. Consciousness and sensation are unimpaired. An occasional ptosis is the only sign of muscular involvement within the distribution of cranial nerves.

Death is reported to have occurred during an attack. Potassium chlorid in 10 to 15 gr. doses will avert or cut short an attack.

MYASTHENIA GRAVIS

Although there is rarely any muscular wasting in this malady it may appropriately be considered here, since the constant feature in its symptomatology is a disturbance of muscular power without discoverable nervous system disease. There are no heredo-familial factors.

Ætiology.—It is of unknown ætiology, is slightly more common in women than in men, and develops during adolescence or early adult life, though rarely an onset in elderly persons is seen. Occasionally it coexists with exophthalmic goitre. There is reason to think that the essential disorder in this disease has its seat in the neuromuscular junction. When the nerve impulses reach this junction acetyl-choline is liberated and renders the muscle fibres sensitive to the nerve impulse.

But if this substance be not liberated, or if it be prematurely destroyed, muscular contraction either fails or is ineffective.

One or other of these abnormalities is probably present in myasthenia gravis. It has been found that the injection of physostigmine (or of the synthetic product "Prostigmin") will temporarily abolish this defect and cause the complete—or almost complete—disappearance of all the symptoms of myasthenia gravis in a very dramatic fashion the effect lasting for two or three hours. Where diagnosis is uncertain this fact provides us with a diagnostic test. Four cubic centimetres of prostigmin with $\frac{1}{100}$ gr of atropine sulphate (to check the peristalsis which would otherwise occur) are injected hypodermically and in about half an hour the patient's muscular condition is approximately normal, and so remains for a few hours.

Morbid Anatomy—An enlarged persistent thymus is commonly but not constantly found. Small foci of mononuclear cells (lymphorrhages) are found in the muscles especially the oculomotor muscles, the liver, and the myocardium. Occasionally there may be some muscular atrophy with degenerative changes in the muscle fibres. Nothing is known of the significance of these changes.

Symptoms—The essential symptom is the rapid development of fatigue and transient paresis in voluntary muscles. Muscles supplied by both cranial and spinal nerves are affected. The extrinsic ocular muscles are almost constantly affected in varying degree and in a given case may for long periods be exclusively involved. Ptosis, variable squints and diplopia, dropping of the jaw and weakness in mastication, weakness of phonation, articulation and deglutition may all occur, and any of the trunk and limb muscles may be similarly affected. In severe cases the least exertion may produce a transient weakness of the muscles employed and render the patient incapable of any activity. In some instances the muscular affection is severe and widespread and death may occur within a few months of onset from failure of the respiratory muscles. In other cases the malady runs a chronic course and in these the ocular muscles are predominantly or even exclusively affected, and permanent paralysis of ocular movement may result. If this involve all the ocular muscles the eyes come to rest in the median position and diplopia disappears.

Occasionally the pupillary reactions are defective while ptosis may be replaced by lid retraction and some exophthalmos.

Striking variations in the clinical course of the malady occur, and patients apparently in grave danger of respiratory paralysis may regain power and remain for long periods free

from symptoms. Faradic stimulation also temporarily exhausts the muscle which may cease to react for some seconds. Usually the tendon jerks remain active and inexhaustible.

Diagnosis depends largely upon the variability of the symptoms upon their increase by exertion and by the absence of qualitative change in the reflexes or of sensory loss.

Prognosis—As has been said above the malady may prove rapidly fatal, may undergo apparent arrest or long remission or may become localised to the ocular muscles and remain chronic over a long period of years. It is probable that the younger the patient and the wider the involvement of limb and trunk musculature the worse the prognosis as to duration of life.

Treatment—All exertion or emotional excitement must be avoided. Massage and electrical stimulation of the muscles are contraindicated. There is no certainly effective method of treatment for this malady. The influence of prostigmin is temporary and its repeated administration may lead to grave increase of weakness after the effects of a given dose have passed off. The dose for intramuscular injection is 1 to 2 mgs and atropine sulphate (gr 1/100) may be given with it to inhibit the peristalsis it evokes. Prostigmine may also be given orally from four to eight 15 mgm tablets being the daily dosage so spaced as to facilitate the taking of food. Again a single dose may tide the patient over a period of respiratory embarrassment.

Some cases maintain an improved level of muscular power when kept on ephedrine sulphate (gr $\frac{1}{2}$ t.d.s.) and favourable results have also been claimed for glycine (gr 50 to 100 twice daily). Complete or almost complete remissions of very long duration (months or years) are not uncommon and render the assessment of treatment difficult.

POLYNEURITIS

(Multiple Peripheral Neuritis)

Under these titles we are concerned with a strikingly uniform reaction of the nervous system to various poisons which also simultaneously affect the heart muscle. While the damage suffered by the peripheral nerves is responsible for the clinical manifestations of polyneuritis the central neurones of brain and spinal cord do not escape and themselves present pathological changes. With certain exceptions it is the functions of the spinal nerves which are affected and one of the features of the condition is the bilateral symmetry of the

paralyses and other symptoms. The essential lesion is a parenchymatous degeneration of the nerve fibres.

Ætiology—Despite the apparent diversity of the poisons which give rise to it polyneuritis displays a remarkable clinical and pathological uniformity. A wide range of chemical substances from arsenic to alcohol and such complex substances as the exotoxins of diphtheria may give rise to it while it develops in typical form in such metabolic disturbances as beri beri and diabetes. Finally it is not uncommonly encountered when no discoverable cause is operative. In these circumstances we may ask whether these diverse agencies do in fact act directly upon the nervous system to produce a single mode of reaction or whether they may perhaps do so indirectly and in virtue of a common disorder of metabolism induced by them—a disorder in the course of which a single toxic metabolite is produced in the body to become the direct neural and myocardial poison. We cannot yet say that such an hypothesis covers every ætiological variety of polyneuritis but there is evidence suggesting that many varieties are so induced e.g. beri beri, alcoholic polyneuritis and the polyneuritis which is occasionally seen in gastric ulcer or carcinoma or in hyperemesis.

Carbohydrates are essential to the metabolism of nerve cells and vitamin B₁ is essential to their oxidation within the cell. In the absence of this vitamin this breakdown in the nerve and cardiac cells is arrested at the stage of pyruvic acid formation and it is conceivable that this substance is toxic for the nervous system. It has to be remembered however that in beri beri the best established example of B₁ avitaminosis the symptoms and the lesions are referable not to nerve cells in the brain but to the axis cylinders of peripheral nerves. Therefore it is evident that the chain of processes leading to the development of a polyneuritis in the presence of vitamin B₁ deficiency still contains undiscovered links.

It has been suggested that vitamin B₁ deficiency may arise either from deficient vitamin intake (as in beri beri) or from defective absorption of vitamins in the alimentary canal (as in gastric ulcer and hyperemesis).

However whatever the facts may ultimately prove to show there remains a considerable residue of cases of polyneuritis both acute in onset and of gradual development and chronic course in which in the present state of knowledge it is impossible to invoke any mode of avitaminosis. Such are the varieties of polyneuritis known as Landry's paralysis, acute febrile polyneuritis and a more chronic variety often associated with some papilloedema and a great increase of protein in the

cerebro spinal fluid These are found to occur in subjects apparently healthy *adequately nourished and free from all discoverable infections*

In short the problems of polyneuritis are still far from complete solution

It is customary to include lead among the metallic poisons producing polyneuritis but both clinically and pathologically the nervous affections arising from lead poisoning differ from polyneuritis and therefore lead paralyses will be dealt with separately This applies also to the clinical pathological phenomena associated with other chemical poisons such for example as carbon disulphide

The symmetry with which the peripheral nerves mainly those innervating the limbs are involved in polyneuritis and the associated myocardial affection justify the assumption that the various poisons concerned circulate in the blood stream and gain access to the nervous system from this source but in the case of one form of polyneuritis namely diphtheritic paralysis there occur certain local paralyses which suggest another possible channel of access of poisons to the neurone namely, the perineural lymphatic space

Morbid Anatomy—The essential lesion in the peripheral nerve fibre is a parenchymatous degeneration most intense at its distal part The myelin sheath is most severely damaged, being broken down into fat globules The axis cylinders are degenerated and there is proliferation of the cells of the sheath of Schwann A less severe degree of fibre change and some nerve cell change is also seen in the brain in long standing cases In fatal cases the heart muscle shows fatty infiltration and myocardial degeneration

Cerebrospinal Fluid—This usually shows no abnormality but a slight increase in the protein content is sometimes found Rarely the increase may be considerable and the fluid of a yellow colour

Symptoms—The following description applies to the polyneuritis of alcohol arsenic and of organismal toxins with certain qualifications to be given later The onset is insidious For weeks or even months before disability ensues the patient complains of painful cramps in the calf muscles at night and of aching in the leg muscles on exertion There are also tingling and subjective numbness of the extremities Examination at this stage reveals tenderness of the limb muscles to pressure especially of the calf and plantar muscles slight blunting of all forms of cutaneous sensibility over the feet and occasionally over the hands The arm jerks are generally brisk and the knee

ARSENICAL NEURITIS—Single massive doses of arsenic or repeated small doses given therapeutically or otherwise may produce polyneuritis. It has been known to occur from the free application of an arsenical paste to a large ulcer.

In cases in which single or repeated large doses have been given a history of acute gastro intestinal and cardiac symptoms may be obtained and in these circumstances a mental state comparable to Korsakow's psychosis (vide p. 1016) may occur. The general course and symptoms are similar to those described above. Wasting and contracture may be extreme and the skin of the palms and soles shows a condition of hyperkeratosis while on the abdominal wall there may be seen the characteristic arsenical pigmentation. In such cases arsenic may be identified in the skin, hair and urine.

DIPHTHERITIC NEURITIS—The sequence of events is rather different from that described above and the clinical picture contains elements absent from the neuritis due to poisons other than the toxin of diphtheria. This difference however is entirely due to the fact that the poison gains access to the system from a strictly localised and peculiar focus namely from the fauces. At the end of the first or during the second week of diphtheria there may develop regurgitation of fluids through the nose, a nasal quality in the voice and a defect of near vision. These phenomena are due to paralysis of the soft palate and to paralysis of accommodation and they may persist for any period up to three or four weeks from the date of appearance. Sometimes ptosis, squint and diplopia occur. No other nervous symptoms may develop in the patient but in some cases at about the fifth or sixth week and often as the palatal and ocular phenomena are clearing up the patient develops a polyneuritis like that described above.

It differs however in some minor details. Its development is more rapid than that of the polyneuritis due to alcohol and it very rarely leads to long standing paralysis or wasting. In fact diphtheritic paralysis is perhaps the only organic nervous disease in which the patient's relatives may with some confidence be given the assurance that complete and permanent recovery within from six to eight months will ensue. It is the commonest form of polyneuritis in children. From time to time cutaneous and wound infection by the diphtheria bacillus occurs and may be followed by diphtheritic paralysis. In such cases however the initial palatal paralysis is absent and is replaced though not in all cases by an initial local paralysis of muscles at or near the site of the focus of infection. It is probable that while the polyneuritis is a blood borne intoxication of the

jerks also, but almost invariably there is diminution or loss of the ankle jerks. As the malady progresses weakness develops in the muscles below the knee, foot-drop becomes evident and gives rise to the so called "steppage" gait in which the patient overflexes the leg in walking to clear the ground with the dropped feet. This phenomenon is not so much due to a selective weakness of the dorsiflexors as to the natural dropping of the foot under gravity and examination will reveal that plantar flexion is also weak. With progressive weakness the patient is ultimately confined to bed and muscular wasting appears. The arms are similarly but often later and less severely involved. Simultaneously with these motor changes the tendon jerks in arms and legs finally disappear, and loss, or rather impairment of all forms of sensibility develops. This last, like the weakness and wasting, is most profound over the distal segments of the limbs. When loss of the sense of position is marked before weakness takes the patient off his legs Rombergism and ataxy of gait make their appearance. Only in exceptional and very severe cases does weakness of sensory loss invade the trunk. Sphincter control remains intact. If the condition be allowed to progress profound wasting of limb muscles with fibrous contracture and deformity develop. Foot-drop is thus rendered a permanent deformity, and the legs tend to become fixed in flexion. Trophic and vasomotor disturbances are present, and of a severity proportionate to the motor and sensory disturbances. The skin of the feet becomes cyanosed and clammy and may perspire freely. The skin of the fingers becomes shiny and thin and the nails curved and rigid.

Pain in the affected muscles and cutaneous hyperalgesia may be extreme. In all developing and advancing cases of polyneuritis there are signs of myocardial involvement of which while the patient is bedridden tachycardia and possibly some dilatation of the heart are the most constant. In the polyneuritis of diphtheria and in beri beri there is a special liability to sudden fatal heart failure.

ALCOHOLIC NEURITIS—This is now a relatively uncommon disease. The majority of the patients are women addicted to steady drinking. In many chronic alcoholics there are to be found on examination the initial signs of a polyneuritis, which never develops fully. Characteristic of the polyneuritis due to his poison is the extreme tenderness of the muscles and the severity of the weakness and wasting seen in some cases. There may also be intense superficial pain and hyperæsthesiæ of the extremities. Bilateral facial weakness is sometimes seen.

ARSENICAL NEURITIS—Single massive doses of arsenic or repeated small doses, given therapeutically or otherwise, may produce polyneuritis. It has been known to occur from the free application of an arsenical paste to a large ulcer.

In cases in which single or repeated large doses have been given, a history of acute gastro intestinal and cardiac symptoms may be obtained, and in these circumstances a mental state comparable to Korsakow's psychosis (*vide p 1015*) may occur. The general course and symptoms are similar to those described above. Wasting and contracture may be extreme, and the skin of the palms and soles shows a condition of hyperkeratosis, while on the abdominal wall there may be seen the characteristic arsenical pigmentation. In such cases arsenic may be identified in the skin, hair, and urine.

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nervous system the initial local paralyses are the result of an ascending perineural lymphatic infection.

Polyneuritis in other infections resembles the polyneuritis of diphtheria.

DIABETIC NEURITIS is due to the action of toxic substances produced during the course of an aberrant metabolism. It is rarely as severe as the forms that have been considered above but may be discovered in the routine examination of a diabetic subject. On the other hand a form of peripheral neuritis characterised by severe ataxy and by intense pains in the legs like those of tabes dorsalis may occur during the course of diabetes. To this the name *pseudo tabes peripherica* has been applied. Again a sudden severe neuritis of a single nerve may occur with resulting paralysis and sensory loss. The ulnar and anterior tibial nerves may be affected in these circumstances.

BERI BERI is also a form of toxic polyneuritis the aberrant metabolism responsible in this case arising from the use of a diet lacking in vitamin B₁. Clinically and pathologically it resembles the forms described above differing only in the presence in some cases and at some stage of their course of a generalised oedema.

ACUTE FEBRILE POLYNEURITIS (*Acute Infective Polyneuritis Landry's Paralysis*)—It is probably a single condition that is referred to by these three titles. Following a brief and somewhat featureless febrile illness a severe and rapidly developing polyneuritis develops often with facial diplegia and in fatal cases with a rapidly ascending paralysis of the trunk muscles leading to respiratory paralysis. When death does not ensue the extent and severity of the paralysis tends to wane rapidly though complete recovery may be delayed for some months. Pain and sensory loss are minimal in this variety.

ERYTHROEDEMA POLYNEURITIS (*Pink Disease*)—This is a disease of early childhood in which a short lived febrile reaction is followed after a variable interval of from a day to two or three weeks by an acutely developing polyneuritis with this is associated a bright erythematous rash in omnia anorexia and marked mental dejection.

The nature of the symptoms named will suggest the lines of treatment necessary. These include careful feeding the use of drugs to secure sleep local treatment to relieve the intense irritation caused by the rash.

The combination of polyneuritis and intense erythema are characteristic of the malady.

Most cases if carefully tended recover in from nine to twelve months.

Prognosis of Polyneuritis—This necessarily depends upon the severity of the paralysis the degree of wasting that has occurred and the presence of contracture when this has been allowed to occur. If in a case of acute onset treatment is adequately carried out from the outset a virtually complete recovery can be looked for though it will take close upon twelve months at least to secure. In the case of a relatively mild post-diphtheritic paralysis recovery may occur sooner than this but the patient will probably not be ready to resume normal activity in less than six or nine months. The presence of deformity of course renders recovery slower and less perfect.

Treatment—Even in mild cases in which no severe degree of paralysis is present rest in bed is the first essential of treatment until improvement has definitely begun. The associated cardiac condition is another indication for rest.

There can be no doubt that a premature return to physical activity after mild and undetected diphtheria may be responsible for the development of a polyneuritis which the subject might otherwise escape and therefore particularly in the mild cases of polyneuritis associated with infections caution in this respect is most important. In severe paralysis the maintenance of a good position of the limbs is essential and the legs should be kept extended adducted rotated in and with the feet supported. When the forearm muscles are severely involved similar precautions are necessary. The presence of pain may prevent any active manipulation or massage of the limbs but this should be carried out when possible. Electrical stimulation of the muscles is of no value and may do harm if strong currents are employed. In the matter of drugs pain may require treatment by aspirin and allied compounds but the morbid process cannot be directly influenced by drugs. General tonic treatment is indicated and strychnine is a useful agent. In alcoholic cases some attempt may be made to deal with the addiction. Since it is possible that there is a common aetiological factor of a metabolic order underlying most or all forms of polyneuritis and it has been shown experimentally that a diet defective in vitamins A and B₁ may lead to nerve fibre degeneration the administration of these substances therefore is rational in polyneuritis. These may be given in severe cases in the form of vitamin B₁ concentrates in daily intramuscular doses of from 20 to 100 mgms. continued as long as necessary. They may also be given in the form of yeast—half an ounce of baker's yeast daily or as Marmite. It is of course not to be expected that the results will be as dramatic as have been recorded in the so called experimental beri beri of birds and

the use of these preparations does not dispense with the necessity for the other therapeutic measures already mentioned. Indeed it cannot yet be said that the duration of the illness and of the ensuing disability have been lessened in polyneuritis since intensive vitamin B₁ therapy has become general.

LEAD PARALYSIS AND ENCEPHALOPATHY

The general features of lead poisoning are dealt with elsewhere (p. 248) but we may say here that involvement of the nervous system may occur both in industrial and accidental poisoning with lead. When it occurs the patient as a rule presents the general features of plumbism and gives a history of lead colic some weeks or months before the onset of nervous symptoms. The so called lead palsy is the commonest nervous sequel of lead poisoning. The extensors of the fingers are first affected, then the extensors of the thumb, except the extensor ossis metacarpi pollicis (abductor pollicis longus) which may be little affected, and finally the wrist extensors. The supinator longus (brachio radialis) commonly escapes as does also the flexor group of muscles. "Wrist-drop" is the most striking result of this selective paralysis. In some instances there appears a slowly progressive wasting of the intrinsic muscles of the hands associated with a corresponding degree of weakness. In severe cases the upper arm muscles may also be involved, deltoid, biceps, and brachialis anticus being most severely paralysed. Rarely, a similar condition may be seen in the legs.

In subjects of chronic lead poisoning not presenting this characteristic picture of lead palsy, tremors, cramps in the muscles, and shooting pains in the limbs may be present.

Prognosis and Treatment—The paralysis of the extensors under appropriate treatment, namely, rest in the position of relaxation and massage, may completely recover, but the atrophy and weakness of the hand muscles tend to be persistent.

The ordinary measures, described elsewhere, for the elimination of lead from the system are employed.

Lead Encephalopathy—Disturbance of cerebral functions may also be a result of lead poisoning and is indeed the common mode of nervous involvement in children. Convulsions, delirium, and coma coming on acutely, sometimes associated with fever and ending in death may occur. Chronic cases also occur with recurrent convulsions and progressive mental deterioration. The character of the physical disturbances

vary widely from case to case. Papilloedema and residual paralytic symptoms of hemiplegic character are common in the cerebral forms of plumbism.

INTERSTITIAL NEURITIS

Under this heading is described a common affection characterised clinically by (1) severe pain in the course of a nerve plexus or nerve trunk, with tenderness of the affected nerve on pressure; (2) pain and tenderness in muscles supplied by the affected nerve trunk or plexus; (3) hyperæsthesia and paræsthesiæ in the cutaneous distribution of the affected nerve or plexus; (4) the absence in most, though not in all, cases of any severe degree of motor or sensory loss. Pathologically, the lesion consists of an inflammatory swelling of the connective tissue elements which knit the nerve bundles and trunks together.

Ætiology and Pathology.—Interstitial neuritis is a malady of adult life. It is commonly associated with fibrositis, and arises by a direct extension of the inflammatory process from fascial structures in the neighbourhood of nerve plexuses and trunks. A common example of this association is the development of sciatica in connection with lumbago. Occasionally arthritic processes in joints may spread to adjacent nerve trunks. The causation of fibrositis and of interstitial neuritis remains extremely obscure, and whether infection or metabolic disorders, of the type of which gout is an example, are in question is unknown. The widely accepted view that connects oral sepsis with fibrositis and interstitial neuritis is somewhat speculative, but has led to much unwarranted and fruitless extraction of teeth. Common precipitating factors are trauma and exposure to cold.

A severe interstitial neuritis, generally of the brachial plexus, is an uncommon sequel of injection of sera, nearly always of anti-tetanic serum. Rarely, diphtheria antitoxin administration may be followed by a localised interstitial neuritis in a nerve trunk.

If the nerve trunk be exposed at operation during the acute stage of the malady it is seen to be swollen and hyperæmic; and when the sheath is incised there is a serous exudation. In long-standing or recurrent cases sclerosis of organised exudate and new fibrous tissue may lead to scarring and constriction of the nerve.

The common seats of the process are the trunks entering into the brachial and sacral plexuses, any of the nerve trunks

derived from these, branches of the upper cervical nerves, and occasionally the anterior crural (femoral) nerve

Symptomatology—Common to all cases of interstitial neuritis, irrespective of their topography, is a relatively acute onset of (1) severe pain radiating along the course of the nerve. This may be of great intensity and is described as "burning," "stabbing," or "loring." It occurs in severe accesses with an aching pain of lesser intensity between the paroxysms. Movement cold, and sometimes the warmth and immobility of the limb associated with sleep may provoke pain. (2) The affected trunk or plexus is extremely painful on pressure and on stretching. (3) The muscles supplied by the nerve are painful and very tender to pressure, on stretching, and on active contraction. They may show fibrillation and a slight degree of wasting, but in the majority of cases there is no true weakness. (4) In the distribution of the cutaneous branches of the nerve burning pruritus, hyperæsthesia, and various paresthesiæ are usual, objective sensory loss is exceptional. (5) In the early acute stage the tendon jerks of the affected muscles are increased, but may later become diminished, as in the case of the ankle jerk in severe sciatic neuritis.

The following special varieties of interstitial neuritis may be briefly described

SCIATICA AND SCIATIC NEURITIS

These two terms are applied to a single condition, namely, interstitial neuritis of the sciatic nerve or of the nerve trunks entering into its formation. A "symptomatic" sciatica may result from pressure on these nerve trunks by new growths, but is accompanied by more severe objective disturbances than true sciatica. The onset of sciatica may be acute or subacute and may follow lumbago. It is a disease of early and middle adult life is most frequent in males, and an attack may be precipitated by trauma, fatigue, or exposure to cold. Frequently there is no discoverable immediate factor of this nature.

The symptoms are very characteristic, and consist in pain along the course and distribution of the nerve, from pelvis to lower extremity. The nerve trunk and its branches are tender on palpation and pain is produced on stretching the nerve by flexing the extended leg at the hip. The muscles supplied by the nerve are extremely tender to pressure and to stretching, and also on contraction. They may fibrillate and show a slight degree of wasting. In rare cases there may be weakness of the dorsiflexor group of muscles of a degree leading to

footdrop. There are often paræsthesiæ over the cutaneous distribution of the nerve, that is, over the outer side of the leg and the dorsum of the foot and the sole. Diminution or absence of the ankle jerk is often seen in severe cases, the other tendon reflexes in the two lower limbs being notably brisk. When standing, the subject rests the body weight on the sound limb and holds the painful limb slightly flexed at hip and knee, adducted and rotated in and with the heel raised from the ground. A compensatory scoliosis accompanies the tilting of the pelvis necessitated by this posture of the leg.

In favourable cases the pain is most severe at the onset and gradually diminishes with rest, recovery taking place in from four to eight weeks. In other cases pain tends to persist and the condition to become chronic and subject to exacerbations in succeeding winters. Second and third attacks occur, but are not usual.

Diagnosis.—Few conditions are more frequently diagnosed on inadequate grounds than sciatica, though few have more clearly defined and readily recognisable physical signs. Osteoarthritis of the hip-joint is the condition in which this error is most commonly made, though the presence of limitation of the range of passive movement at the hip and of pain in the joint on full adduction or abduction, and the absence of the special signs of sciatica should make differentiation possible. Sacro-iliac disease may also be confused with sciatica if the signs of the latter be not looked for. In all joint conditions radiography frequently, but not invariably, reveals the presence of arthritis. The symptoms of sciatic neuritis when associated with cachexia and with marked weakness, wasting, or sensory loss in the distribution of the nerve, or with indications of a bilateral sciatic nerve affection, should always arouse the suspicion of pressure from new growth, and pelvic examination should be made.

Treatment.—In all cases of sciatica, both those with acute and severe onset and those that develop subacutely, an immediate retirement to bed is essential. The longer this is delayed, the longer the duration of the malady and the less responsive it becomes to subsequent treatment. The period of such rest will depend upon the severity of the symptoms, but several days complete freedom from pain and discomfort should be obtained before the patient is allowed to move about. Unless this step be taken no form of local treatment can be expected to afford relief. Radiant heat and hot applications to the limb give relief from pain. Diathermy in skilled hands is sometimes of use in the later stages of the

affection but given too early may aggravate the pain a muscular tenderness. This caution applies also to the use of massage which indeed plays a secondary role in treatment. A form of treatment that is occasionally successful consists in the injection into the epidural space of the sacral canal of a solution of normal saline (60 to 80 cc) following a preliminary injection of 10 cc of a 0.5 per cent solution of novocaine. The needle is thrust upwards into the canal from its lower end and the solution slowly injected. This procedure may be repeated at five-day intervals as many as four times if relief follows the early injections.

As regards drugs the combination of aspirin with phenacetin (gr v of each) is a valuable one but in the intense pain of the initial stage morphia is occasionally necessary as a temporary measure. When severe pain has passed passive movements and massage to the affected limb are useful. The immobilization of the patient in a plaster spoint or by means of a long Liston splint for from two to six weeks has been successfully employed in intractable cases.

Psychoneurotic symptoms are not infrequently grafted on to the clinical picture of chronic sciatica and pain and a limp or gait may be complained of for months after objective signs of the malady have passed. In this connection it is of interest to remember that once the ankle jerk has become diminished it may never regain its former briskness. Therefore a diminished ankle jerk is not necessarily evidence of active sciatica.

HERNIATION OF THE NUCLEUS PULPOSUS (PROTRUSION OF THE INTERVERTEBRAL DISC)

In an uncertain proportion of what appear to be cases of chronic sciatic pain it has recently been found that there is protrusion of the intervertebral disc into the lumen of the spinal canal. Pathologically the lesion is a herniation of the nucleus pulposus of the disc and aetiologicaly trauma is responsible for the herniation. The type of injury in question is usually a sudden strain due to the effort of lifting some heavy object while in a stooping or asymmetrical posture. The discs involved are in 90 per cent of cases those between the fourth and fifth lumbar or the fifth lumbar and first sacral vertebrae.

The diagnosis of herniation of the nucleus pulposus is not being made with somewhat undue frequency and often upon clinically inadequate grounds. Since this diagnosis commonly involves the intrathecal injection of lipiodol

other contrast medium, followed by laminectomy, it is clearly very important that it should be made only upon conclusive grounds, for both these procedures may be followed by persistent and disabling symptoms, and we are not yet in a position to say to what extent in a labouring man laminectomy may impair his normal capacity for his work.

Clinically the symptom complex of herniation of either of the two discs named is as follows. There is a long history of chronic, disabling pain low in the back, which precedes by months or years the appearance of pain in the leg of sciatic distribution. The latter pain is characteristically aggravated by coughing, sneezing, or straining. There are paræsthesiæ (tingling, numbness, cold sensations) on the outer side of the leg below the knees, or over the foot. The lumbar spine is stiff, and stretching the sciatic nerve by elevating the extended leg as the patient lies supine increases both pain and paræsthesiæ. There may be some tilting of the iliac crest on the side of the lesion with spasm in the erector spinae. The ankle jerk is often abolished. Paralysis or weakness of muscles is exceptional. Over the paræsthetic areas of skin there may be some objective blunting of sensation.

In the absence of these signs and symptoms the diagnosis is not justified, and in their presence it is doubtful if intrathecal lipiodol injection is necessary. Certainly it should not be performed unless it is already decided to proceed to operation, since this substance left in the subarachnoid space may give rise to persistent symptoms of root irritation. In any case an adequate period of rest and the use of the measures adopted when the diagnosis of sciatica is made should be an invariable preliminary both to the final diagnosis and to the treatment of herniation of the nucleus pulposus. Operative procedure less drastic than laminectomy are in course of development for the removal of fragments of herniated disc, and in the meantime it should be emphasised that laminectomy should not be lightly undertaken, or recommended, save at the hands of the experienced neuro surgeon. An unskilled laminectomy is a severe trauma that may have disabling sequels for patients likely to be engaged in laborious work.

BRACHIAL NEURITIS

This is a common form of interstitial neuritis in adults of both sexes. The onset may be apparently spontaneous, or may be precipitated by strain or cold. It is subacute, pain appearing and increasing rapidly in intensity. At first pain is

referred to the root of the neck over the brachial plexus it then spreads down the limb to the hand. There are frequently foci of intense pain limited to small areas on the lateral side of the upper arm or in the palm. In character the pain is constant but subject to paroxysmal exacerbations which are described as stabbing burning or boring. The subject cannot lie on the shoulder of the affected side in bed and when standing the pain is aggravated if the limb be allowed to hang free from the shoulder. Examination of the limb reveals physical signs of the nature mentioned above but rarely is there any definite weakness or objective sensory loss. However the brachial neuritis which may on rare occasions develop as part of a serum reaction after administration of anti-tetanic serum is usually characterised by marked paralysis of deltoid biceps brachio-radialis and the scapular muscles. The tendon reflexes are commonly increased in the ordinary cases of this condition.

Course—Under favourable conditions of treatment the acute process may die down in from three to six weeks but may on the other hand prove very intractable to all forms of treatment and persist for months with varying intensity of pain. Usually recovery takes place sooner than in the case of sciatica.

Diagnosis—Arthritis of the shoulder cervical spondylitis and cervical rib may produce pain of comparable distribution and intensity but the nerve trunk tenderness of neuritis is absent from these conditions which present their own characteristic signs.

Treatment—The limb must be kept at rest and supported by a sling. It may be advisable to put the patient to bed. Radiant heat and other forms of local heat give relief from pain. Aspirin combined with phenacetin in 5 gr doses of each are also useful for this purpose. After the first period massage and diathermy may be employed. Diathermy exerts its beneficial effect in virtue of the heat generated in the tissues through which the current passes and for no other reason and the relief of pain thus produced is the most valuable effect of this form of high frequency current.

Cervico Occipital Neuritis—The pain radiates over the distribution of the upper cervical and great occipital nerves. There may be associated fibrositis of the neck muscles and some spondylitis of the cervical spine.

For all these forms of interstitial neuritis the principles of treatment laid down for sciatica apply.

NEUROMA

The nerves may be the seat of tumours which are known *neuromata*. In the *true neuroma* or *ganglioneuroma*, nerve fibres and ganglion cells form part of the structure of the tumour. This rare form of neuroma is found only in connection with the sympathetic nervous system in the thoracic or abdominal cavities. The *false neuroma* or *neurofibroma* is much more common. It arises in the connective tissue of the nerve and may be central separating the nerve fibre bundles situated at the side of the nerve trunk. It may be the seat of cystic or myxomatous degeneration. Neurofibromata may be single or multiple and in the latter case the tumours may be confined to a single nerve or nerve plexus or be widely distributed. In size they vary from tiny nodules to large masses several inches in diameter. They are congenital of unknown origin and may be found in epileptic or mentally defective subjects. It is the solitary *fibroneuroma* which is usually responsible for symptoms and these consist in pain along the course of the nerve and also though rarely in sensory and motor symptoms. In *multiple neurofibromatosis* numerous tumours of soft consistence stud all the peripheral nerves. Occurring on cranial or spinal nerve roots they usually produce compression symptoms. Neurofibroma on the auditory nerve forms the so called *acoustic tumour* or tumour of the *ponto cerebellar angle*.

When multiple neurofibromatosis is associated with *cutaneous pigmentation and the presence of multiple sessile and pedunculated tumours on the skin* the condition is known as *von Recklinghausen's Disease* or *Molluscum fibrosum*.

Tubercula dolorosa is the name given to collections of tiny neurofibromata situated on the terminal twigs of cutaneous nerves and giving rise to considerable tenderness and pain.

All these forms of tumours on nerves tend to be progressive but do not call for treatment unless pain or in the case of tumours within the skull and vertebral canal signs of compression of adjacent structures occur. In these circumstances the offending tumour may be removed when possible.

AFFECTIONS OF THE SPINAL NERVES

GENERAL OBSERVATIONS ON PERIPHERAL NERVE LESIONS

The symptoms of a peripheral nerve lesion may be of one of the following four types (a) complete interruption

(b) compression with partial interruption, (c) partial interruption with signs of irritation, and (d) partial interruption with signs of regeneration

The majority of cases of isolated affection of one or more peripheral nerves are traumatic in origin, at least in those cases where there is severe interference with conduction, and partial interruption is on the whole more common than complete interruption. The following clinical criteria are of value in differentiating the four syndromes given above

In Complete Interruption there is total paralysis of all muscles exclusively supplied by the nerve. These muscles waste rapidly and profoundly, and, for a period of some weeks beginning from about the third week after interruption has occurred show the reaction of degeneration. The essential elements of this reaction are a loss of faradic excitability, an increased and altered galvanic excitability. The threshold of effective stimulation by the continuous current may be lowered, and the resulting contraction is slowed and tends to pass as a wave down the stimulated muscle from one electrode to the other. The polar alteration so commonly described as part of the reaction of degeneration is an inconstant and unimportant thing. The significance of this reaction is that the muscle which shows it is completely denervated for the time being. Such a muscle when tapped with a percussion hammer responds by the same slow wave like type of contraction as is seen on using the galvanic or continuous current, and by careful tapping in this way as much information may be obtained as by electrical testing and with considerably less difficulty.

The paralysed and wasted muscles are painless to pressure, tactile sensibility being lost over a wider area than is pain sense. The area of sensory change is maximal for the nerve affected. Pressure on the nerve below the level of the lesion does not produce a tingling sensation in the cutaneous distribution of the nerve.

In Compression with Partial Interruption — The muscles supplied by the nerve may not be completely paralysed though they generally show some wasting. They are usually very tender on pressure or on stretching. This is especially the case with muscles supplied by the internal popliteal division of the sciatic nerve and those supplied by the median nerve. In minimal lesions of the nerve this tenderness may be more prominent than weakness, and may constitute a graver disability on account of the pain produced by voluntary contraction. As in complete interruption the tendon jerk of any muscle affected is usually lost. The electrical reactions

may show no qualitative alteration. The area of sensory change may be less than the complete distribution of the nerve concerned. There is usually a small area of total pain and temperature loss surrounded by a larger area of complete tactile loss within which there is qualitatively altered sensation to pain and temperature. Pinprick is peculiarly painful and diffuse in the sensation it evokes within this area. This alteration cannot be described as representing protopathic sensibility. The hypothesis which postulates epicritic and protopathic forms of cutaneous sensibility is no longer generally accepted and the genesis of these forms of altered sensibility is obscure.

Partial Interruption with Signs of Irritation — This syndrome is always the result of partial division by a wound or of the involvement of an intact nerve trunk in cicatricial tissue from an adjacent wound. The greatest degree of irritation is seen in median and internal popliteal nerve lesions. The irritation varies in degree from slight pain and cutaneous hyperæsthesia with muscle tenderness to excruciating burning pain in the affected region and severe trophic lesions. The signs of interruption of conduction may be trivial. The most severe type is that associated with *causalgia*, a form of pain which may be of intense severity, and when long lasting reduces the sufferer to a pitiable state. The pain is aggravated by any movement active or passive of the part or by a jarring of the bed on which the patient lies. The pain is mainly superficial. This clinical picture is commonly the result of gunshot wounds which have just glanced the nerve without severing any or many fibres. Motor signs of irritation are contracture and fibrous infiltration of muscles, muscular spasms and rarely actual hypertrophy of muscle.

Signs of Regeneration are both motor and sensory. On the motor side the pilomotor muscles in the affected cutaneous area regain function and the limb muscles regain tone before voluntary power returns. On the sensory side percussion of the nerve below the lesion elicits a tingling sensation within the skin area which is the seat of sensory loss. All forms of cutaneous sensibility begin to return together first at the proximal end of the anæsthetic area but sensations elicited by stimuli here are referred to the distal end of the anæsthetic area (peripheral reference). Gradually the area of sensory change lessens in size beginning to recede at the proximal end. Thermal and painful sensations are not to be intensified and to be badly localised.

The electrical reactions also begin to return to normal and trophic lesions to clear up.

LESIONS OF THE BRACHIAL PLEXUS AND OF NERVES DERIVED FROM IT

The brachial plexus is derived from the lower four cervical and the first thoracic spinal nerve roots. These roots are purely morphological in the arrangement of their nerve fibres, whereas the nerve trunks issuing from the plexus distally are physiologically arranged, flexor muscles being supplied by one nerve, extensors by another. The function of the plexus is to effect this rearrangement, and it follows that the topography of the sensory and motor paralyses in plexus lesions will depend upon the situation of the lesion. There are thus three possible types of plexus lesion: radicular lesions involving the roots entering into the plexus, plexus lesions involving the trunks and cords, and distal lesions which correspond to combined lesions of the peripheral nerves.

Radicular Lesions form the majority of cases and fall into two groups: (a) upper plexus type in which the fifth and sixth cervical roots are concerned, and (b) lower plexus type in which the eighth cervical and first thoracic roots are concerned. (a) The muscles supplied by the fifth and sixth roots and affected in lesions of these roots are the deltoid, biceps brachialis anticus, supinator longus (brachio radialis), supra and infra spinatus, serratus magnus (S. anterior), rhomboids, clavicular part of pectoralis major and subscapularis. The sensory loss involves the outer aspect of the shoulder and upper limb. Biceps and supinator jerks may be lost. (b) The eighth cervical and first thoracic roots supply the flexor muscles in the forearm and the small hand muscles. The sensory change includes the ulnar aspect of forearm and hand. There may be an associated cervical sympathetic paralysis in first thoracic root lesions. Lesions of the trunks and cords of the plexus are not so common as those of the roots or of the upper trunk formed by the junction of the fifth and sixth cervical roots. Occasionally, also in gun shot and stab wounds the posterior cord of the plexus may be injured giving rise to sensory and motor symptoms in the distribution of the circumflex and musculo spiral (radial) nerves.

Ætiology of Brachial Plexus Lesions—The majority of plexus lesions are traumatic in origin and arise from the violent forcing of the shoulder and arm into abnormal positions. Thus traction on the arm, falls on the shoulder, or pressure exerted on the shoulder from above may tear the upper plexus roots either at their points of attachment to the cord or in the intervertebral foramina. In forced adduction of the shoulder

the clavicle may be forced backwards and may compress the plexus against the first rib. The familiar type of birth palsy involves the fifth and sixth roots or the trunk formed by their union and results from force exerted on the arm when this does not present normally.

Upper plexus lesions form the majority of cases and the lower plexus type is relatively uncommon, except when associated with a lesion of the upper plexus.

Apart from trauma the nerve roots entering into the plexus may be involved within the meninges by tumours or by syphilitic or tuberculous inflammatory processes, within the vertebral foramina by arthritic changes by tuberculous caries or by new growth in the neck by new growth or by gunshot or stab wounds. The production of plexus injury by cervical or first thoracic ribs is dealt with below.

Symptomatology—In upper plexus lesions there is both weakness and wasting of the affected muscles deltoid and biceps being usually the most severely affected and showing a reaction of degeneration. The arm hangs adducted with the forearm pronated. It cannot be abducted nor can the elbow be flexed. The extent and degree of sensory loss is very variable. In slight injuries one or more of the muscles innervated by the damaged roots may escape. In lower plexus lesions there is weakness and wasting of the hand muscles and oculo pupillary (cervical sympathetic) symptoms when the first thoracic root is injured near its point of origin from the cord.

Treatment—The processes of repair which follow severe injuries to the plexus and include fibrosis and matting of the nerve trunks render surgical treatment out of the question in all but exceptional cases. The treatment of paralysed muscles must be carried out on the lines laid down in the section dealing with Acute Poliomyelitis (p. 936) and pain when present may be treated by radiant heat and suitable drugs.

Obstetric Paralysis of the Brachial Plexus—As has been mentioned these are more commonly of upper than of lower plexus type. They usually arise in head presentations when the shoulder is delayed or the arm extended and when these structures are manipulated or pulled upon. Traction on the arm or forcible lateral flexion of the neck may tear the roots either at their attachment to the cord or in the intervertebral foramina. In a typical birth palsy the muscles paralysed are deltoid biceps brachialis anticus supinator longus and brevis (brachio radialis and supinator) and infraspinatus. The humerus is rotated inwards the forearm extended and the hand pronated. Usually there are no sensory phenomena.

Less commonly a lower plexus paralysis with signs of cervical sympathetic involvement occurs. Associated complications may be fractured clavicle and humerus, dislocation of the shoulder, and hæmorrhage into the sternomastoid.

Prognosis—Unless recovery takes place rapidly and becomes complete within a few weeks, improvement is likely to be slow and recovery incomplete.

Treatment—The arm should be fixed in an abduction splint in severe cases for a short time, and subsequently the use of the arm should be encouraged by bandaging the normal arm to the side for short periods. Massage may be of some value. The slight cases recover without treatment.

RIB PRESSURE ON THE BRACHIAL PLEXUS CERVICAL RIB

Certain anatomical variations occur in the segmental derivation of the brachial plexus. Thus the plexus may receive a large quota of fibres from the fourth cervical root and an unduly small one or none from the first thoracic root. Such a plexus is said to be prefixed. On the other hand, less commonly, the fifth cervical quota is small, and a large quota from the second thoracic root is present. Such a plexus is said to be post fixed. The development of the costal elements of the vertebra follows that of the plexus, so that with a prefixed plexus a supernumerary rib may develop from the seventh cervical vertebra, while a post fixed plexus may interfere with the development of the normal first thoracic rib, which then retains a rudimentary form. When the adjustment between plexus and ribs is perfect no abnormal pressure is exerted on the roots, but when the development of the costal process is in excess of the plexus alteration, the lowest nerve root in the plexus may be stretched over the costal element, and symptoms of neuritis and damage arise. Thus a cervical rib may stretch the seventh and eighth cervical roots, or a rudimentary first thoracic rib may similarly affect the first thoracic root. The following types of rudimentary rib occur: (1) an exaggerated costal process of the seventh cervical vertebra which is prolonged forwards and downwards as a fibrous band, to be attached to the first rib; (2) a short rib articulated at its origin and continued as above; (3) a long jointed cervical rib attached by a fibrous band to the normal first rib; (4) a cervical rib articulated at each end anteriorly with the first rib; (5) a rudimentary first thoracic rib attached to the sternum by a fibrous band. The first and last of these forms are not readily visible in a radiogram but may yet be responsible for plexus pressure.

Whether the injury to the nerve root is caused by the bony or the fibrous part of the rib depends upon the length of the former

Ætiology.—While supernumerary ribs are usually bilateral, though not invariably symmetrical, pressure symptoms are commonly unilateral and do not develop until adult life, generally in the third or fourth decade. The common factor in the various immediate causes of symptoms is a lowering of the shoulder girdle, with a resulting increase in tension on the root stretched by the rib. Such causes are muscular hypotonia after confinement or in debilitated states, a degree of manual activity unusual for the subject, strains, and repeated traction on the arm. Women, in whom the shoulder girdles normally lie somewhat lower than in men, form the majority of cases.

Symptomatology.—This may be entirely or largely subjective, or there may be muscular atrophy, sensory loss, and vasomotor changes in the limb. The initial symptoms are pain and paræsthesiæ. Both symptoms tend to be maximal in the hand, but vary greatly in distribution and intensity from case to case. Usually the pain radiates down the fore arm into the hand and digits, it is aggravated by anything which depresses the shoulder girdle, such as carrying a parcel or wearing a heavy coat, and is relieved by elevating the shoulder girdle. It may come on with great intensity while the patient is in bed. These subjective symptoms may persist for many months without the development of any objective motor or sensory changes. When muscular wasting appears, it conforms to one of two types, a median type with a selective incidence of wasting in abductor pollicis brevis and opponens pollicis alone. The thenar eminence then is flattened in its radial half, the shaft of the metacarpal bone becomes subcutaneous, while the other thenar muscles escape. This type of wasting is pathognomonic of cervical rib pressure. The other type of muscular atrophy corresponds to an ulnar distribution, the wasted muscles being the interossei, and the hand tends to assume the "main en griffe" posture. Sensory changes are variable and inconstant, they may be on the radial or the ulnar side of the arm, the former in thenar atrophy and the latter in the ulnar type. There is a clinical type in which vasomotor symptoms predominate. These consist of redness, cyanosis or œdema of the hand with subjective sensations of heat or cold. The radial pulse may be smaller than on the normal side in those rare cases where the subclavian artery is rused over the rib. In rare cases of

this kind blood clot may form in the subclavian artery, and embolism occur distally, blocking the artery in the arm at its bifurcation at the elbow, or one of its distal branches. In these circumstances gangrene may develop in one or more finger tips. When this happens it is likely to be in a case which presents no signs of nerve pressure. The other vasomotor signs, however, are probably due to pressure on sympathetic fibres in the eighth cervical root.

Diagnosis.—The presence of long-continued pain and paræsthesiæ in one arm, especially in a woman, when associated with vasomotor changes, should lead to a suspicion of cervical rib and to an X-ray examination of the neck. Muscular atrophy may be considerably delayed in many cases, and appear only after long months of pain. A history of factors which relieve or aggravate pain is of importance for the reasons given above. When atrophy is present the condition has to be differentiated from progressive muscular atrophy and lesions of the lower cervical enlargement of the cord. In these the small hand muscle wasting is global, and rarely selective as in the thenar type of wasting described. Moreover, some degree of involvement of the second hand develops sooner or later in both these conditions.

Diagnosis presents greatest difficulties when radiograms yield no definite information, as may be the case with a fibrous "rib," and no objective motor or sensory symptoms are present. In these circumstances a careful history will generally suffice to distinguish rib pressure from brachial neuritis.

Treatment.—When there is no muscular atrophy and pain is the prominent symptom, complete relief may be obtained by measures which tend to raise the normal level of the shoulder girdle. At first the arm may be carried in a sling, and then massage and remedial exercises designed to raise the tone and power in the girdle muscles should be carried out. General tonic treatment and careful attention to the patient's nutrition and amount of exercise are important. Pain may be relieved by the use of aspirin, phenacetin, and allied drugs.

When muscular atrophy is present it is doubtful if any treatment short of surgical removal of the rib is adequate, and in some cases where pain persists in spite of the measures described above, removal may be necessary.

THE PHRENIC NERVE.—Paralysis of this nerve is uncommon, but when present may be due to lesions of its cells of origin in the third, fourth, and fifth cervical segments of the cord (poliomyelitis, motor neurone disease, compression); to lesions

of its roots (vertebral disease meningitis) or to lesions of the nerve in neck or thorax where it is occasionally involved in new growths or inflammatory processes. The symptom is paralysis of the diaphragm. When unilateral this may be difficult to detect apart from radioscopic screening. When bilateral there is slight dyspnoea on exertion, and bulging of the abdominal wall on inspiration.

When associated with paralysis of other respiratory muscles the danger of death from asphyxia is considerable unless some function is rapidly restored.

THE CIRCUMPLEX NERVE—The nerve may be damaged in injuries to the shoulder or be affected by a toxic parenchymatous neuritis. The symptom is paralysis of the deltoid with or without sensory loss in the skin covering the lateral aspect of this muscle. In complete lesions the deltoid wastes rapidly and profoundly and recovery is generally delayed and imperfect. The arm cannot be abducted and forward and backward movements of the arm are weakened. Arthritic changes in the shoulder joint may occur in permanent paralysis of the muscle.

THE LONG THORACIC NERVE (nerve to serratus anterior)—This nerve innervates serratus magnus. It may be damaged in injuries to the shoulder region by excessive strain as in carrying weights or in keeping the arm elevated and out stretched unduly.

It is not infrequently affected alone by toxic processes (after diphtheria typhoid influenza and other infections). There is often some associated paralysis of the middle or lower part of trapezius. The normal function of the serratus magnus is to draw the scapula upwards forwards and outwards and to advance the point of the shoulder. When paralysed elevation of the arm is slightly weakened and when the arm is advanced to the horizontal the vertebral (medial) border of the scapula stands out from the thorax and is said to be winged.

THE MUSCULOSPIRAL (RADIAL) NERVE—Owing to its long and exposed course this is the most frequently injured branch of the brachial plexus. The majority of lesions are traumatic the nerve being damaged as it passes round the outer side of the arm. Simple compression is the commonest form of injury, the arm being pressed against something hard or compressed by a tourniquet. It is rare for the nerve of a perfectly healthy subject to sustain damage in this way, the majority of the patients being chronic alcoholics whose peripheral nerves are already poisoned. Other predisposing factors are debility

chronic plumbism, and recent infections such as typhoid. Other forms of injury are the involvement of the nerve in fracture of the shaft of the humerus, and pressure on the nerve in the axilla by a crutch.

Symptomatology—This varies according to whether the nerve is damaged distal to the offset of the branch to the triceps or not. In the former case triceps and anconeus escape, and the supinators, extensors of the hand and of the fingers, and the extensors and long abductor of the thumb are paralysed. There is wrist drop, and the wrist and digits cannot be extended, except that the interossei maintain extension of the distal and middle phalanges. The grasp is weakened owing to the flexion at the wrist which accompanies it, and which is due to loss of the synergic fixation of the wrist that is part of the complete movement of grasping. Supination of the forearm is lost, except when the biceps is contracting and the elbow flexing. In crutch paralysis the triceps is involved also. Sensory loss is inconstant, but when present occurs over the radial half of the dorsum of the hand and over the proximal segments of the thumb, index, and middle fingers.

Prognosis and Treatment—Recovery is the rule except in severe crushing of the nerve in association with fracture. Slight pressure palsy recovers rapidly without special treatment, but in severer cases where the muscles show a reaction of degeneration, recovery is delayed. The essential part of treatment is the placing of the paralysed muscles in the position of physiological rest that is moderately shortened. This is done by the use of an anterior forearm and hand splint, which keeps the wrist and digits slightly extended. Active exercises should be carried out daily, care being taken to prevent full extension of the parietic muscles.

THE MEDIAN NERVE—Isolated paralysis of the median nerve is not common, and is generally traumatic in origin. It may be affected with other nerves in compression of the hub. Slight median nerve paralysis associated with interstitial neuritis is sometimes found in hand workers (joiners, locksmiths, ironers, etc.). Toxic parenchymatous neuritis of the nerve occasionally occurs in association with various infections.

Symptomatology—When the nerve is damaged in the upper arm the following muscles are affected: flexor carpi radialis, flexor sublimis and part of flexor profundus digitorum, the pronators, flexor longus pollicis, opponens pollicis, abductor brevis pollicis and flexor brevis pollicis, and the lateral two lumbrical muscles. The full extent of sensory change includes

the palm of the hand radial to a line drawn along the long axis of the limb down the middle of the ring finger and also the palmar aspect of the digits and thumb. On the dorsum it includes the distal portions of the same digits. In incomplete lesions a less extensive area of altered sensibility may be present. In addition to these objective motor and sensory phenomena in incomplete lesions of the nerve there may be marked tenderness of the parietic muscles, severe pain in the distribution of the nerve, the so called *causalgia*, and trophic changes in the skin and nails of the affected area. Thus the nails may be rounded and furrowed and the skin shiny and atrophic.

Prognosis and Treatment—The prospects of recovery in severe lesions is by no means so good as in the case of the musculospiral nerve. In traumatic lesions resection and resuture may be called for.

THE ULNAR NERVE—This nerve is more commonly injured than the median. Isolated lesions are generally traumatic. The nerve may be crushed in fractures of the internal condyle (medial epicondyle) of the humerus or may become later involved in callus formation after such a fracture. The paralysis of the nerve in the latter case is gradual and may be long delayed. The nerve may be exposed to repeated minor injuries as it lies behind the condyle and develop a neuritis with paralytic symptoms. An isolated toxic neuritis of the nerve occasionally follows some infection.

Symptomatology—Ulnar nerve paralysis is peculiarly disabling to the hand owing to the paralysis of the interossei. The thumb cannot be adducted and the little finger is almost immobilised. The fingers cannot be flexed at the metacarpophalangeal joints or extended at the distal joints though in this respect the index and ring fingers are less disabled than the remaining digits. Gradually the claw hand is produced by the overaction of opponents of the interossei, the fingers are hyperextended at the proximal and flexed at the distal joints. The hypothenar eminence disappears and the mesial part of the thenar eminence.

LESIONS OF THE LUMBAR AND SACRAL PLEXUSES

The lumbar and sacral plexuses and the peripheral nerves of the lower limb are much less frequently affected than the plexus and nerves of the upper limb. Isolated paralyses of anterior crural (femoral) or obturator nerves are rare and while the sciatic nerve is more frequently the seat of disease it is rarely completely paralysed apart from gunshot wounds.

THE SCIATIC NERVE—The nerve trunk, or the roots which enter into its formation may be involved by tumours of the sacrum or in the pelvis or by a syphilitic radiculitis. The nerve is commonly the seat of an interstitial neuritis which is the pathological process responsible for sciatica a condition which has already been described (p 942)

In damage to the nerve from pelvic lesions, tumours or compression exerted by the foetal head in pregnant women it is the peroneal division of the nerve which bears the brunt of the damage. The symptoms of a lesion of the peroneal (lateral popliteal) division in this situation are paralysis or paresis of the dorsiflexors of the foot and toes of the peronei with sensory loss over the outer aspect of the leg and over the dorsum of the foot. The foot hangs down in the equinovarus position and cannot be dorsiflexed or everted. Secondary shortening of the calf muscles may render the foot-drop a permanent disability.

THE PERONEAL NERVE—Special emphasis should be laid upon the isolated affection of this nerve since it is not uncommon. It may occur in otherwise healthy adults quite apart from discoverable local injury. In these circumstances its aetiology is unknown. Its appearance is often preceded by pain along the outer side of the leg. After this has been present for two or three days a sudden paralysis usually severe in degree of all the muscles supplied by the nerve is seen. The foot hangs loosely down in the position of equino varus. The patient can stand on tiptoe but he cannot dorsiflex the foot and he cannot run. There is sensory loss of varying degree over the outer aspect of the leg and on the dorsum of the foot to the base of the toes. After some weeks a degree of wasting of the affected muscles makes its appearance but is rarely profound. Recovery is very slow and frequently incomplete. Among the special circumstances in which this nerve may be paralyzed are compression of the nerve trunk by a garter or a bandage round the upper end of the fibula where the nerve winds round the bone. In diabetes and occasionally in typhoid this nerve may be the seat of a neuritis. Treatment consists in the wearing of a foot drop support by day and of a night shoe when in bed so that the foot is constantly kept at right angles to the line of the leg.

THE TIBIAL OR MEDIAL POPLITEAL NERVE—Apart from gunshot wounds and comparable injuries isolated paralysis of this division of the sciatic nerve is uncommon. In complete lesions the symptoms are paralysis of the calf and plantar muscles and sensory loss over the sole of the foot and the

posterior aspect of the leg in its lower half. The atrophy of the plantar muscles renders the sole hollow, the proximal segment of the toes is hyperextended and the terminal segments flexed. Perforating plantar ulcers may develop when sensory loss is complete.

THE ANTERIOR CRURAL (FEMORAL) NERVE—Paralysis of this nerve is very rare, and when it occurs is the result of pelvic injuries. The symptoms are paralysis of the psoas, pectineus, sartorius and quadriceps. There is loss of the knee jerk and weakness of extension of the knee. There may be sensory change on the anterior and medial aspects of the thigh. An uncommon malady is an interstitial neuritis of the lateral cutaneous nerve of the thigh known as *meralgia parasthetica*. It occurs in males and its symptoms are pains, paræsthesiæ, and slight objective changes in sensibility in the territory of this nerve on the front and lateral aspect of the thigh. The symptoms are brought on by standing or walking.

THE OCCUPATION NEUROSES

Under this heading is included a group of disabilities in which the characteristic symptoms are provoked by the effort to carry out some habitually performed muscular action, commonly an action by which the subject earns his livelihood. It follows that the disability appears in the muscles which perform this action and ends by preventing its accomplishment. The two essential symptoms are spasm and cramp-like pain in the affected muscles. Those who carry out repetitive movements with the right hand and arm are the subjects of the malady, such as clerks, telegraphists, hammermen and sempstresses. Hence we speak of writer's cramp, telegraphist's cramp and so on. At its onset an occupation neurosis of this type appears only when the specific action is being carried out with a given group of muscles, but in severe and long standing cases other co-ordinated movements performed by these muscles also come to be impeded in execution. By far the commonest clinical type of occupation neurosis is writer's cramp, and what is to be said of its ætiology, prognosis and treatment applies to other varieties of "cramp."

WRITER'S CRAMP—*Ætiology*—Hitherto males have formed the majority of the patients, but with the entry of women into clerical occupations it is possible that this statement may have to be modified in due course. The patients are clerks in the third, fourth, or fifth decades of life. There are frequently, but not invariably, evidence of a neuropathic inheritance and

indications of instability in the subject himself. In writing there are two motor components, pen holding and pen moving. Faulty habits of pen moving are probably important factors in the production of writer's cramp, and it is this aspect of the act of writing which is predominantly affected. Those who perform the movements of the pen wholly with the thumb and index fingers or from the wrist downwards employing the arm as a whole little or not at all, are throwing the greatest strain upon a small group of muscles, and appear to be specially liable to this form of occupation cramp. Shorthand writers are said to be immune from this disability.

Symptoms—The onset is gradual. After a spell of writing the subject finds the pen getting slightly out of control and causing slight disfigurements of his handwriting. He notices that he is grasping the pen with undue firmness, and that the hand readily tires and aches. The thumb and index gradually tend to go into flexion spasm and to slip up the pen, and he cannot freely extend these digits to move the pen up and down the paper. The writing becomes jerky and heavy from the force with which the pen is pressed upon the paper. Gradually the forearm muscles are invaded by spasm, and in course of time the writing of a few words brings the hand to a stop with the pen tightly grasped in the flexed thumb and index. At first all other hand and finger movements are performed with normal freedom but gradually these also tend to become difficult and painful. In some patients pain is prominent from the outset and may remain the predominant symptoms throughout cramp being minimal.

Different methods of holding the pen give transient relief but finally all devices of this kind fail and the patient becomes unable to write at all. Even the left hand may be invaded if the subject changes hands with his pen and learns to write left handed.

Course—The symptoms increase progressively until the attempt to write is finally abandoned and the hand is rested for a prolonged period. Usually recurrence attends the subsequent resumption of writing but not invariably.

Diagnosis—Although the symptoms of writer's cramp are extremely characteristic numerous pitfalls beset the early diagnosis of the condition. Any slowly progressive lesion involving the central nervous mechanism of movement tends to affect finely co-ordinated purposive movements before coarser or simpler movements are impaired or before there is obvious paresis. Therefore difficulty in writing may be simply the expression of such a slowly developing disorder of movement.

Paralysis agitans is an example of such an insidiously developing malady which may interfere with freedom of writing before other disabilities are complained of, and this is especially apt to be the case in a professional writer. Other comparable organic diseases will come readily to mind in this connection, and the presence of these should be excluded by thorough investigation before a diagnosis of writer's cramp is accepted. Again, any peripheral nerve affection or joint affection which gives rise to pain on movement of the hand or arm may impair the freedom and comfort of writing. Finally, any painful affection of the tissues of the hand should be excluded.

Treatment—Although writer's cramp is in all probability primarily due to defective methods of writing, the malady develops at a time when re education in the act cannot be carried out. Rest is the first essential of treatment, and should be for not less than six months, even in the slightest cases. In the absence of such rest no improvement can be expected. The value of local treatment such as massage or electrical stimulation, is uncertain. Their use encourages the patient, and their withholding may lead him to feel that nothing is being done for him. Mild galvanism and gentle massage with active exercises are the best forms of local treatment to allow in these circumstances. It is important to attend to the patient's general health and nutrition.

If the patient resume writing, the use of a broad pointed nib and of a thick penholder is advisable.

In violin and piano players, neuralgic or painful forms of occupation neurosis are more common than muscular spasm, but some spasm in the fingers may be present. Treatment must be carried out on the lines indicated above.

THE TICS

A tic has been defined as "a co-ordinated purposive act, provoked in the first instance by some external cause or by an idea, repetition leads to its becoming habitual, and finally to its involuntary reproduction without cause and for no purpose." There are psychical and motor components in a tic. The motor component may consist of sudden jerky co-ordinated movements endlessly repeated. This form is most common in children, and tends to involve the facial, laryngeal, pharyngeal, and upper limb muscles predominantly. This is the so called simple tic. More complicated reactions may occur consisting in the repetition of some complex act. A special variety of motor disorder allied to the tics is spasmodic torticollis.

In a few cases there is no obvious motor component, but the patient is swayed by imperative ideas and is subject to periodical explosive utterances.

All forms occur in mentally unstable individuals, in whom other neuropathic symptoms may be present.

SIMPLE TIC: HABIT SPASM.—This is a malady of highly strung children during the second five years of life. Its onset may be precipitated by ill-health or debilitating factors. The facial muscles are commonly affected, and the child blinks, wrinkles its forehead, or makes any of a series of jerky grimaces. The arms may also be the seat of similar jerky movements. The disorder is increased by anxiety or emotion of any kind, can be controlled momentarily, and ceases during sleep. When the laryngeal musculature is affected the child may make repeated clicking or other sounds. The malady may persist for many months, and even for years. It is often associated with nail-biting, difficulties in feeding, and restless and disturbed sleep. Usually the symptoms clear up entirely, but recurrent attacks are not uncommon.

Diagnosis.—The disease with which simple tic is most likely to be confused is Sydenham's chorea. In chorea the movements are not repetitive, they lead to dropping of objects held in the affected hand, and to defects of articulation. The hand-grasp of the patient with chorea is irregularly sustained. The opposites of all these features obtain in simple tic.

CONVULSIVE TIC.—In this relatively uncommon form the movements have the same character as those of simple tic, but are much more violent and widespread, involving sometimes the whole musculature. Complicated and grotesque gestures may occur in periodical outbursts, and the patient commonly presents marked mental instability.

PSYCHICAL TIC.—In this form, although there is no muscular spasm in the strict sense of the word, the malady does find motor expression in repeated explosive utterances, which may consist of words, phrases, or sentences. The repetition of words heard in this way is spoken of as echolalia, while if the utterances be obscene we speak of coprolalia. Anxiety neurosis symptoms may be added to this picture, and definite psychotic symptoms may ultimately develop.

Treatment.—The child's general health must first receive attention, and any adverse factors in its home and school environment, psychological or physical, be corrected. The constant reprimands to which many such children are subjected by over-anxious parents are detrimental to recovery. Perhaps the most essential element in successful treatment is the wise

management of the child both at work and play. It not infrequently happens that the patients are the children of unstable parents who are ill fitted to assist treatment in the required directions. Firm but kindly discipline, carefully graded physical exercises, a nourishing dietary and, in the matter of drugs, the use of moderate doses of bromide will suffice to effect cure in the majority of cases. Similar considerations should guide treatment in the case of convulsive and psychical tics, but with these the prognosis is invariably bad.

SPASMODIC TORTICOLLIS—In this condition there is irregular tonic and clonic spasm of the muscles which rotate the head. Sometimes the extensors of the neck are also involved. As a result the head is periodically forced into abnormal positions. The condition is momentarily under control but considerable mental effort may be needed to restrain the spasm for more than a few seconds.

Ætiology—It is a malady of adult life, and may occur in persons of any age from the later years of the third decade onwards. The sexes are equally affected. Commonly it arises without any precipitating factor which is discoverable, but pain from cervical spondylitis or fibrositis in the neck muscles may be the exciting factor in a predisposed person. Anxiety and worry are other exciting factors. Most of the patients are highly strung, emotional individuals with a neuropathic inheritance. Recently the view has been put forward that the spasm is the expression of a small lesion of the corpus striatum, but there is no evidence in favour of such an hypothesis. It must be remembered that the carriage of the head in the erect position is a very complex and recently evolved function, and one, therefore, which may easily be disordered from a variety of causes other than focal disease in the brain.

Symptomatology—The onset is usually very gradual, the patient becoming slowly aware of a tendency of his head to turn to one side. At first he can control this, but with lapse of attention, and particularly under any kind of stress, the movement gains in frequency and force. The neck muscles are bilaterally involved, but on simple inspection the muscle most obviously in spasm is sternomastoid. The crossed trapezius is usually affected simultaneously, and as the malady progresses other muscles enter into spasm. With powerful action of the neck extensors, the head may be retracted (retrocollic spasm), and associated with this is overaction of the frontals and elevation of the eyebrows. This is a normal association when the head is thrown back voluntarily, and its presence here

indicates that we are dealing not with simple muscular spasm but with a more complex phenomenon, namely, a movement involving normally co-operating muscles, and probably initiated from a high cerebral level. The spasm may be almost wholly tonic, or clonic exacerbations may be superimposed upon it, and the predominantly tonic form cannot be differentiated in respect of aetiology or causation from the clonic variety. In severe cases cramp like pain usually accompanies the spasm, and the latter may be so forceful as to require considerable effort to overcome it passively. Hypertrophy of the sterno mastoid is sometimes seen in long-standing cases. It is said that deviation of the head to the left is more common than to the right.

Prognosis and Treatment—Massage, active exercises against resistance, and general rest will sometimes effect a temporary cure. The patient may be kept flat on his back with the head between sand bags for several weeks, but old or debilitated patients do not tolerate this immobilisation at all well. The use of a light celluloid splint may be sufficient to restrain the spasm and to give relief in some cases. The administration of bromides is useful in many cases as an adjuvant to local treatment. In view of the fact that we are dealing with an abnormal movement and not with peripherally arising spasm, it is to be expected that motor nerve or nerve root section should give unsatisfactory results. This is indeed the case, and the original spasm being stopped by paralysing the muscles concerned is apt to be replaced by the development of comparable spasm in other neck muscles. However, occasional successes are obtained by extensive denervation of muscles, a severe operation for which old and debilitated subjects are unfitted.

F M R WALSH

PSYCHOLOGICAL MEDICINE

DEFINITION—Psychiatry is that branch of medicine whose special province is the study and treatment of all types and degrees of mental ill health, however produced

Put in the most general terms, mental ill health is experienced subjectively as a substantial impairment of comfort and happiness, and is shown objectively as a substantial impairment of efficiency, or of the capacity for satisfactory social relationships

It is of course, true that these effects are usually produced as the result of physical disorder or disease, and although general medicine has in the past been little concerned with such psychological and social considerations yet these are always important aspects of every illness, and should be considered in every case. Psychiatry, however, whilst emphasising the importance of the commonly neglected psychological aspect of illness, has no desire to claim the whole of medicine as its domain, and it is only when the psychological aspect should be regarded as being predominant that a patient becomes primarily a psychiatric problem

In 1938 there were 158,723 patients notified as under care in the mental hospitals of England and Wales (3.9 per thousand of the population), and 23,153 patients were admitted to mental hospitals for the first time. It has been estimated that 1 in 35 of all born is certified at some time before death, while of those reaching adolescence the proportion is, of course, still higher

In addition there were 89,904 patients in institutions for mental defectives (2.2 per thousand of the population), but this falls far short of the total number of defectives in England and Wales, which has been estimated at 300,000. The figures for Scotland are comparable

There are no reliable figures available as to the number suffering from minor forms of mental ill health (frequently masquerading as physical disease), of insufficient severity to necessitate institutional care, but none the less potent causes—

of personal misery and social inefficiency. There can be no doubt, however, that this group is an enormous one. It has even been estimated as 30 per cent of all sick persons (Report of B.M.A. Committee on Mental Health).

When to the above is added the large army of the socially undesirable and inadequate—criminals, drunkards, prostitutes and many more with an important psychiatric aspect—it will be realised that the magnitude of the problem which confronts psychiatry reaches dimensions much larger than that provided by any one branch of general medicine, and is comparable with that confronted by general medicine as a whole.

ÆTIOLOGY OF MENTAL DISORDER

The basic ætiological principle in psychiatry is that (1) psychological factors, (2) physical factors, and (3) constitutional factors must be considered in every patient.

These terms mental, physical, and constitutional, of course really only denote aspects of the total activity of conscious human beings. It is however, convenient to separate them, and to regard both normal and abnormal behaviour as resulting from the interaction of the three corresponding factors. Moreover it must be remembered that these three groups of factors—mental, physical and constitutional—are inevitably and invariably present and operative, though they may be regarded as varying greatly in their practical importance from individual to individual and from case to case.

Now clearly it would be unreasonable to expect either the normal or abnormal behaviour of human beings that issues from the complex series of interreactions of these three factors to be wholly explicable in terms of any one member. Thus, there is never a single and simple cause for normal behaviour, nor is there ever a single and simple cause for mental ill health.

The necessity for such a triple approach can sometimes be seen in an almost diagrammatic way. Thus, a man, whose mother had been in a mental hospital, developed influenza as the result of which he lost his job and became profoundly depressed. Few cases show their mixed ætiology quite so clearly but all possess it, and it is one of the tasks of psychiatry to try to assess the relative importance of the different causes in a particular case.

Certain consequences of this basic principle of triple ætiology may now be mentioned —

(a) Since physical factors are always present, and may be

extremely important in producing mental symptoms it follows that psychiatry cannot be sharply separated from general medicine. A general medical training and a sound knowledge of general medicine are, therefore, essential for psychiatric study and practice.

(b) The view is sometimes held that mental illness has always a physical cause. It is, of course, true that the development of mental symptoms can quite frequently, as in senile dementia or febrile delirium, be regarded as the more or less direct consequence of physical disorder or disease. But it would be wrong to assume that this must always be so. Psychological factors can also be extremely important, and there is no logical or scientific necessity whatever for the assumption that mental symptoms may not result as the more or less direct consequence of psychological causes, or, for that matter, of constitutional causes. In brief, any of the three groups of factors can assume predominant importance.

(c) Even when, as in senile dementia or febrile delirium, the occurrence of mental illness can be more or less directly attributed to physical causes, it will be obvious that the study of such impersonal physical factors cannot possibly account for the individual or personal difference in the mental symptoms displayed. The explanation of the individual psychological symptomatology (content) must clearly be sought in the personal biography of the individual concerned. Thus, to give a crude illustration, a patient cannot harbour the delusion that electricity is played on him unless he has heard of it.

This problem of the distinction between occurrence and content or the problem of the distinction between the ætiology of the condition and the genesis of the psychological symptoms, is a very important one. The elucidation of, for example, physical factors, may throw great light upon the former, but can never throw much light upon the latter, for psychological states can never be completely described or understood with the physical concepts of general medicine. This does not, however, imply that they cannot be approached scientifically.

(d) Mental illness, of whatever origin must have a mental aspect. This perhaps explains if it does not excuse the tendency to the view that mental symptoms are entirely dependent upon mental causes. This of course is equally as erroneous as is the view that mental symptoms are entirely dependent upon physical causes. It is very important, when dealing with mental illness, to be aware of the dangers of a spurious psychogenesis. This may result in the following way. The study of the biography of a patient often discloses psycho

logical experiences that are clearly related to the mental symptoms he shows. But not infrequently these psychological experiences are important only as regards the origin of the psychological symptoms, and it is very easy to make the mistake of ascribing to the psychological experiences that determine the genesis of the psychological symptoms, ætiological importance in the production of the whole reaction, which they do not possess, and which should be sought elsewhere in the physical or constitutional fields.

A simple illustration is afforded by a case of depression (melancholia) a condition primarily of constitutional origin which is frequently characterised by self reproach. Now there are few who have not some cause for self reproach, and the particular topic of self reproach may be given and accepted as the cause of the depression, when it should really be regarded as a consequence.

Each of these three groups of factors—psychological, physical, constitutional—will now be considered in greater detail. It will soon be apparent how artificial is the separation and how much they are inter related and overlap.

Psychological Factors—Generally speaking, it can be said that from the psychological point of view, mental symptoms are always produced by emotional disturbance, or by mental activity associated with emotional disturbance. It may often seem that something else is responsible, such as overwork, but it can generally be shown fairly readily that it is not the overwork itself, but the emotional strain under which it has been done, or which has driven the patient to undertake it, that explains the breakdown.

Normal and Morbid Emotional Reactions—We tend to regard as normal any emotional reaction that we can readily understand as being justified by the circumstances. We can, for example, all understand the depression that follows a recent bereavement. There is, of course, no sharp line at which abnormality begins. But, put in most general terms, emotion may become morbid either (1) by reason of its intensity and duration, or (2) because it is produced by what seems an inadequate cause.

Thus, whilst a degree of depression can be regarded as the normal reaction to a bereavement, the development of a profound condition of melancholia cannot be so regarded, similarly, whilst a considerable degree of fear is normal during a bombardment, the development of the same degree of fear becomes pathological when aroused by the task of crossing an empty street.

The Origin of Morbid Emotion—The origin of emotional disturbance must not solely be sought in the nature of the environmental situation, for the reaction to the stress imposed by a particular situation will vary according to the nature of the individual exposed to it. Therefore, two factors—the environment and the individual—must always be considered. Past experience helps to form, but does not entirely determine an individual's nature, and, similarly, present experience helps to form, but does not entirely determine his emotional response.

Psychological causes of emotional disturbance must, therefore, often be sought in the history of the individual, as well as in the stress imposed by the more immediate situation with which that individual is faced, and not infrequently the experiences of more remote origin are the more important.

Inner Stress or "Mental Conflict"—Just as it would be impossible to give all the possible situations of strain that might be imposed by the more immediate environment, so it is impossible to give all the possible causes of more remote origin consequent upon past experience, that may also give rise to emotional disturbances owing to inner stress or "mental conflict."

Thus, there is often a discrepancy between duty and desire, and between desire and achievement, and even when what was desired is attained, it does not always satisfy.

This raises an important aspect of mental conflict. A patient may be and often is, adequately and painfully aware of the nature of his problems, and he may, or may not, be able to cope with them. But often he is not accurately aware of the nature of the conflict going on in his mind, and then its solution becomes a difficult matter, for it is less easy to cope with a situation the true nature of which is not understood or which is mistakenly supposed to be other than it is.

A lack of knowledge of the factors that induce our feelings and dictate our actions is inevitably present in some degree in everyone, but this ignorance is often present in cases of mental disorder, and may be an important factor in their causation.

This lack of knowledge arises because (1) introspection is not available for those factors—physical and constitutional—which are not psychological. Knowledge of these factors must at best be incomplete, inferential, and not direct, (2) because introspection is imperfect even for those factors that are susceptible of introspection, namely, psychological factors.

It would be a mistake to suppose that introspection is

normally, or ever, exhaustive and infallible. It is as easy, and probably much more common, to make mistakes in describing what is in or on our minds, as it is to make mistakes in describing a scene in the outer world. In the one case, as in the other, desires, prejudices, and expectations will distort observation and falsify recollection, so that the real constituents of the scene will be ignored, misdescribed, or a wrong attribution of their origin will be made. These errors will occur more readily if the results of more accurate introspection or observation are disconcerting or disgusting or damaging to the self-esteem and thus calculated to arouse emotions of an unpleasant character.

Such a sequence of events is sometimes described as an example of *repression* into the *unconscious*.

Now if ever a word deserved to be paid overtime it is the term *unconscious*. Indeed, the term *unconscious* has been used in so many different senses that it would seem preferable to limit its meaning to that defined on p. 977, and to call *subconscious* those phenomena which are not remembered owing to emotional factors, or which, if recalled or available to consciousness, are not correctly recognised and correlated because their recognition and correlation would be distasteful or intolerable to the personality.

Again repression does not mean discipline or self-discipline, but the means whereby self-protection is sought, and the preservation of self-esteem attempted, through self-deception or the adoption of the policy of the ostrich. Repression (self-deception) may for some be a helpful or even essential method of achieving an adjustment to life, but for others it may be harmful and crippling by preventing them from realising the true nature of their difficulties which do not cease to exist because they are not recognised, but which, if correctly recognised, they may be able to face and to solve.

It is startling how the inability to connect facts which are obviously related bears no relationship to intelligence. Thus a popular young curate of charm and considerable ability began to develop doubts about religion and shortly afterwards palpitations, sweating and a feeling of collapse at first only when called upon to preach but later at other times as well. After exhaustive physical investigations had proved negative he was seen by a psychiatrist when the above story rapidly emerged, and it was found that he had made no connection between his religious scruples and the development of his symptoms in the pulpit.

The significant psychological factors at work can often

adequately be understood by a careful history taken along ordinary lines, and it is by no means always necessary or wise to seek for the essential psychological causes in the remote past or early childhood. Psychological delving of this type always involves two dangers, namely, either that of leading the victim along tracks which conform to the preconceptions of the investigator, or arriving at facts, attitudes, or problems which are, or which are supposed to be, so universal that they have no value in explaining individual difficulties. Such ætiological whipping boys as the "œdipus situation" or inferiority complex can explain everything and therefore explain nothing. Indeed they approximate perilously to the explanation that would be afforded by attributing a patient's condition to his birth, which has, however the advantage of being quite certainly true.

Furthermore, it must be remembered that, since psychological factors are never the only causal factors, psychological explanations must, of necessity, be incomplete as causal explanations. Even if they account for the particular symptoms that are shown, they may fail to explain why these occurred at the time they did. Thus, the sexual offences of an early pædophile may be interpreted in the light of his "mother fixation" or his aggressive tendencies towards his father, but such interpretative excursions do not explain why he behaved normally before the time of the offence and worse than this, no plumbing of psychological depths can bring to daylight the (unconscious) invasion of the brain by spirochætes.

This example illustrates the dangers of purely psychological explanations, and why it is so mistaken and misleading to regard the unconscious as an explanatory window s-cruse.

The Effect of Morbid Emotion—Emotional upset, however caused, may produce symptoms of either mental or bodily distress or both combined.

A clear recognition of the effects of the physical accompaniments of emotion is of cardinal psychiatric importance. They explain how it comes about that so many patients, who should be regarded as psychiatric problems, do not complain primarily or at all of mental symptoms but do complain of physical symptoms. These patients naturally but erroneously tend to believe that physical experiences and physical symptoms have a physical origin, and do not relate their physical symptoms to emotional disturbance because they cannot see the connection, and often do not want to. Their "resistance" often arises because it is more pleasant to attribute an illness to a potent poison than to a poor personality.

Bodily symptoms of so called "functional" origin will occur more readily if the physical make up of the patient is of such a type that it readily responds to emotional disturbance. Thus, certain individuals with a labile vasomotor system readily respond to emotion with tachycardia, others by fainting. They thereby provide examples of the interrelation of different factors.

Physical Factors—By physical factors are here meant the states of physical disorder or disease that are studied in general medicine—infections, intoxications, disorders of nutrition and circulation, metabolic and endocrine disturbance.

Constitutional as well as "exogenous" physical factors can of course be very important in the production of these conditions, this only serves to emphasise once more how artificial is their separation. But those constitutional factors that are more directly concerned in the production of mental disorder (such as heredity) will be dealt with later.

The Physical Basis of Mental Disorder—Sometimes mental changes can be correlated with general brain damage as in arteriosclerotic dementia and occasionally particular mental symptoms can be correlated with localised brain damage, as in post apoplectic aphasia. But in the majority of mental syndromes neither macroscopic nor microscopic changes have been found in the central nervous system. It must, however, be remembered that our present methods of examination are very crude, and can as yet tell us very little of the presumptive changes in the central nervous system that accompany functional activity normal or abnormal. Electro-encephalography (*vide p 866*) may in time throw some light on these matters.

Indeed unless disordered function is the result of permanent structural change in the brain, the demonstration of abnormal histological findings cannot reasonably be anticipated. It would therefore be a mistake to seek for the pathology of mental disorder only in the pathology of the brain and it would be an even greater mistake to seek it only in neurohistopathology.

The importance of the physical changes that accompany emotion have already been mentioned, and it must be emphasised that these physical changes are just as much a part of an emotional reaction as is the mental experience of emotion, of which indeed they form an integral part.

This mutual relationship and interdependency between the mental and the physical aspect is often particularly well shown in the course of a case of Graves' disease.

The Assessment of Physical Factors—As has been mentioned, physical factors may be of predominant importance in the production of mental disorder, and there is no form of mental disorder, mild or grave, in which physical factors may not play a more or less important contributory part. It must, however, be emphasised that the importance of physical factors is often greatly exaggerated, and that physical abnormality is often coincidental and not causal.

When physical factors are of predominant ætiological importance, as in general paralysis of the insane, the mental changes will be those of an "organic type of mental reaction," the characteristics of which will be described later.

As a working rule it can be taken that, in so far as mental changes resemble less those of an "organic type of mental reaction," and approximate to some other type of syndrome, so does the predominant ætiological importance of physical factors become suspect.

Anything, however, that lowers the general efficiency of the patient will facilitate the development of mental disorder in a susceptible subject, hence arises the importance of physical factors as a contributory cause. As the man in the street rightly believes "worries get a hold" on those who are physically run down in a way they would not otherwise.

Physical Factors of Crude Exogenous Type—Nevertheless although such factors as chronic infections or intoxications, resulting from "focal sepsis" or other cause, should always be sought for and dealt with, their removal or eradication seldom produces that benefit in mental disorder that the student might be led to expect. The importance of physical factors of a crude exogenous type has been in the past, and sometimes still is, grossly exaggerated. In the majority of mental disorders no evidence can be found of "exogenous" physical factors that can reasonably be inferred to possess practical importance, and it seems probable that the physical basis for mental disorder should rather be sought in metabolic and other disturbances of a more subtle kind.

Endocrine Glands—The vegetative nervous system and the endocrine glands exert a profound influence on metabolism, and play an essential part in the integration of mind and body. They are, therefore, of special interest in psychiatry. Although there can be no doubt about their importance, very little exact knowledge is as yet available as regards the role of endocrine glands in the production of mental symptoms. This is well shown in the sexual glands, and is all the more striking as their influence on the mind is best known.

Thus, we know that the highest incidence of psychoses occurs round about puberty and the climacteric, i.e., the times of the beginning and end of the reproductive period, and we know that menstruation is often accompanied by symptoms of emotional disturbance, which can in some women be serious. But we no longer firmly, if vaguely, attribute psychoses to amenorrhœa, or regard masturbation as a cause of schizophrenia. For we now regard amenorrhœa which is very frequent in the case of major psychoses, as the consequence of the deranged metabolism accompanying them, rather than as their cause, and we now realise that masturbation can be regarded as a normal phase in development and that in schizophrenia it is often only a symptom.

Constitutional Factors—PHYSIQUE—The constitutional background may be demonstrated to some extent in the patient's physique and attention has been drawn by Kretschmer to different types which can be observed amongst mental patients as well as in the general population.

1 *The Asthenic or "Leptosomatic" Type* is characterised by a narrow build, angular profile and by a lean, dyspeptic, and hungry look. Individuals of this type look taller than they are. Their skin is poorly vascularised and pale and the distal parts of their extremities tend to be cyanotic. They are flabby and of poor muscular development. Their chest is long, narrow and flat. The subcostal angle is less than 90 degrees.

2 *The Pyknic or "Pyknotomatic" Type* is well demonstrated by John Bull with his large body cavities and generous distribution of fat about the trunk. John Bull in his younger days if a typical pyknic had a handsome body with a graceful motor apparatus and small and delicate extremities.

3 *The Athletic or "Athletosomatic" Type* is recognised by the strongly made skeleton and muscles and is well seen in a certain type of raw boned Scot. It is less clearly defined than the other two but is perhaps more definite than other types that have been described such as the dysplastic.

There is a certain affinity between the pyknic build, cyclothymic make up and the development of manic depressive psychoses on the one hand and on the other hand between an asthenic build, a schizoid make up, and the development of schizophrenic reactions. These facts are of interest and may have some practical value in the assessment of certain mixed and complex mental reactions. But it must be emphasised that these associations are by no means invariable and that there are many exceptions.

HEREDITY—The study of heredity has a much greater practical importance than that of physique in the analysis of the constitutional factors involved in an individual case. There are three methods by which this subject has been investigated.

1 *The study of the family* or relations of the individual patient may disclose the same or similar reactions among them. This may furnish valuable information for a correct assessment of the factors at work, and hence may give indications as to the nature of the treatment that should be adopted. It will of course, be necessary first of all to try to disentangle the effects of environment from direct hereditary influences, and knowledge obtained by the other two methods gives some help.

2 *Twin Studies*—The comparative study of uniovular and binovular twins gives an indication of the relative importance of environmental and hereditary factors, because uniovular twins have the same hereditary equipment, whereas binovular twins are not more closely related genetically than other brothers and sisters. Rosanoff examined a series of schizophrenics who had twin brothers or sisters and found concordance in 65 per cent of the uniovular twins, but in only 15 per cent of the binovular ones, the corresponding figures for manic depressives were 70 and 15 per cent. This proves the strong hereditary element in the causation of these psychoses and gives some measure of the relative importance of exogenous and endogenous factors.

3 *The Study of Familial Incidence*—This method has very great value and the results obtained have definite practical importance. The frequency of a given mental disorder in the relations of the patients suffering from it is compared with the frequency of its occurrence in the general population. The figures obtained by these investigations enable an estimate to be made of the probable degree of danger of the mental disorder occurring in a given relation. These figures, if used with statistical caution, provide the only basis for eugenic measures.

Schizophrenia—The frequency of schizophrenia amongst the general population has been estimated at 0.85 per cent. Among brothers and sisters the incidence is about double of that in the general population (Pollock, Malzberg, and Tuller). Various studies make it probable that it is due to one gene which is transmitted recessively, but twin studies have shown that the "penetrative" power of this gene is only 65 per cent. This means, put in rather crude terms, that

the relative significance of genetic and environmental factors is about 2 to 1. If the children of schizophrenics survive their twentieth year 8 per cent develop the condition, and 50 per cent of the children show a schizoid personality, i.e. they show character traits which are commonly noticed in the pre psychotic personality of the schizophrenic. It is difficult to assess these from the genetic point of view, for some of them may be abortive cases of schizophrenia, and others carriers. Three per cent of the grandchildren of schizophrenics develop the condition, and the prognosis is held to be worse in so far as the character of the parents was abnormal. 1.8 per cent of the cousins of schizophrenics i.e., double the figure in the general population develop schizophrenia, and the figure for nephews and nieces is the same. Further analysis gives the following results: a frequency of 0.9 per cent if neither of the parents is schizoid, 2 per cent if one of the parents is schizoid, and 11 per cent if both parents are schizoid.

Manic Depressive Psychoses—The manic-depressive constitution is probably due to a single dominant gene, but only 20 to 30 per cent of the carriers develop a psychosis. The figures of the liability of the various relations to be affected are 9.5 per cent of the children and 2.5 per cent of the nephews, nieces, and first cousins. The figures for the general population are given as between 0.23 and 0.44 per cent. These figures are worked out for Central European populations, they may differ for the population of the U.K. In New York State incidence of manic depressive psychoses among the relatives of the patients studied is considerably higher than the expected rate, the excess being greatest among sisters of the female sufferers from the disease.

Mental Deficiency—Although the inheritance of the mental defective is much less well known than the inheritance of the psychoses, nevertheless, the results of statistical inquiry are of practical value. Thus, if both parents are mentally defective, 61.5 per cent of the children show mental deficiency as well, if only one, the incidence is 29 per cent. These figures do not pretend to say anything about the relative importance of hereditary and environmental factors.

SYMPTOMS ENCOUNTERED IN MENTAL DISEASE

It is essential for the student to know what are the more important symptoms that may be shown in mental disorder,

and that he should also be clear as to the meaning of the technical terms that have been used to describe them

Unconsciousness—An unconscious patient is neither aware of his environment nor capable of responding to psychological stimuli in a psychologically understandable way (in *accessibility*) He is subsequently incapable of recalling any mental activity during the period in question States of unconsciousness are best observed after severe concussion in deep anaesthesia, and as a final stage of many intoxications Between unconsciousness and consciousness there are various types and degrees of disturbed consciousness

Disturbances of Consciousness.—These disturbances are mainly due to physical causes, and the general characteristics may be given as follows —

- (a) *Deficient grasp and its consequences* The patients have a difficulty in fixing their attention and in grasping what is taking place They therefore do not fully understand the true nature of their situation and consequently cannot adjust their behaviour in a way that is appropriate
- (b) *Disorientation*
- (c) *Disconnected and incomprehensible behaviour*
- (d) *Slowness of thinking and disturbances of retention with subsequent amnesia*

Three intermediate states between consciousness and unconsciousness are often recognised —

- 1 *Dimming or Clouding of Consciousness* (often rather unfortunately called "Confusion") — Less than normal rather than anything abnormal is experienced All mental processes are slow Association of ideas is scanty Thinking is difficult or impossible These patients are apathetic and bemused, show no initiative, are easily fatigued, and it is hard to attract or to hold their attention They tend to pass into a dreamless sleep, stupor, or coma In mild cases the patients may answer and behave rationally under examination, but readily relapse when left to themselves In cases of moderate severity, although out of touch with their surroundings, they may be roused to answer simple questions correctly And in severe cases it may just be possible to get an occasional appropriate response by forcible questioning or commands

- 2 *Delirious States*—The consciousness is clouded, and the continuity of mental processes is interrupted or shattered by abnormal experiences such as hallucinations. Restlessness is a most common feature.
- 3 *Twilight States*—There is a peculiar alteration of consciousness and personality for certain periods of limited duration, with subsequent amnesia. They are mainly encountered in epilepsy (*vide p 1023*), and also rarely in hysteria.

Attention is the term used for describing the experience that certain objects are in the centre of consciousness, whilst others lie more towards the periphery. This distribution may be achieved either voluntarily or involuntarily. Attention may be disturbed in various ways —

1. It may be difficult or impossible to *arouse* the attention of the patient. This generally occurs in organic reactions resulting in disturbed consciousness, but it may also occur in states of "retardation," perplexity, or self absorption due to depression or schizophrenia.
2. It may be difficult or impossible to *keep* the attention of the patient, (a) because the patient returns to predominant preoccupations (depression and schizophrenia), (b) because the attention of the patient is readily distracted by stimuli from the outside, this distractibility preventing concentration on any given subject for any length of time (manic and certain organic pictures), (c) because the attention may have been caught and kept by some incidental stimulus in the external environment from which it cannot be detached (certain organic states).

Volition, General Activity, Motor Behaviour.—*Lack of Initiative* is most frequently seen in neurasthenic states, and in depressive and schizophrenic psychoses but may also be observed in lesions of the frontal lobe or the basal ganglia.

Retardation denotes slowness of speech and action, generally combined with a poverty of impulses and tardiness of response. It occurs in depressions, and when very severe, it may result in depressive stupor.

Psychomotor Hyper activity, together with an increased speed of action is seen in manic states. Impulses may follow one another so rapidly that none are properly carried out or completed.

In Catatonic Excitement the motor behaviour is generally

more disintegrated, and features like *stereotypy* (monotonous repetition in speech and movements) mannerisms, and grimacing, are often observed and are highly characteristic.

Perseveration, as opposed to *stereotypy*, denotes the repetition of a movement or action in spite of the patient's effort or desire to produce a new one. It may be most marked in the field of speech and difficult to distinguish from aphasic disturbances (see p 802). It is common in all organic states.

Stupor means complete suppression of speech, movement, and action not accounted for by profound disturbances of consciousness. It is commonly produced by schizophrenic disturbances of will, but it may result from extreme retardation in melancholic patients. *Flexibilitas cerea* (a peculiar type of "wax-like" rigidity of the muscles), *cataplexy* (the tendency to keep up postures which have been imposed), and *negativism* (automatic resistance to all outside stimuli) are symptoms that are often found.

Suggestion means influence by processes other than reason, *suggestibility* is the capacity—varying in each individual—of yielding to such influences. This normal attribute is increased in states of disturbed consciousness. It is strikingly present in hypnosis, and in schizophrenics it may reach the extreme degree of *automatic obedience*. *Echopraxia* and *echolalia*, i.e. the automatic repetition of actions which are seen, or of words which are heard, are particular examples of this.

Abnormal impulses, such as *kleptomania* (the impulse to steal), *pyromania* (the impulse to set fire to things), are better classified with *compulsive or obsessional phenomena*, i.e. actions carried out under the subjective feeling of being forced to do them, either without or against intention or desire.

Feelings of Passivity (or of being influenced) describe those conditions when patients believe their experiences are produced by some outside agency or force, or that they are under the attempted or successful direction or control of this outside agency or force. These may range from bodily experiences, attributed to electricity, to strangely developed mental experiences, attributed to hypnotism, electrical waves, or the operation of wireless or telepathy.

These phenomena are very common in schizophrenia.

Disturbances of Thought.—*Retardation*, encountered mainly in depressive states, is characterised by slowness or difficulty in the process of thinking often accompanied by a poverty of ideas of which the patients are clearly aware. Many depressive patients who are retarded do not, however, so much complain of slow thoughts or empty minds, as of thoughts that go round

and round hut do not get on. An extreme poverty of association may lead to a form of perseveration very like that seen in organic conditions.

Circumstantiality means slow progression of thought when due to a tendency to digress into trivial hypaths or irrelevancies. This type of thinking can often be found in epileptics, in morons, and in patients with organic diseases of the brain.

Flight of Ideas denotes a severe degree of the manic disturbance of thinking. Manic patients think quickly and have a great wealth of association, but these are superficial and often dictated by rhymes. Manic patients cannot pursue a consecutive line of thought of a purposive kind. Flight of ideas is an exaggeration of the method of thinking which Schopenhauer attributed to certain authors. "They write as if they were playing dominoes. The incidental number of the last piece determines the next, and the following piece has no relation to the last but one." An example of "flight of ideas" is provided by a manic patient who said "maternal, paternal, infernal, Dante."

Incoherence denotes the breaking up of the ordinary sequence or structure of thought into larger or smaller fragments. It is sometimes possible to discover why ideas with apparently no connection are associated with one another. The reason for such associations differ from those that govern ordinary logical thinking. Incoherence occurs in schizophrenia when it has a particular quality and in confusional states as after an anæsthetic. Normal people may experience something very similar in dreams.

Blocking, or a sudden interruption in the stream of thought, occurs in schizophrenia.

Neologisms are frequently invented by schizophrenics. A patient, for instance, described a drawing "Cordron. A theme of curved and fancy lines. stcollic st from ateeple word from the point on the top of the post collic (unexplainable) word matching the point, caller from the cordron and cross piece. Squirrel wirl, from wearl, the curls in the lines which look like a wearl pool."

Predominant Ideas are convictions not based on reason but on an emotional foundation. They are not necessarily pathological, and every normal person tends to develop them in the fields of politics, religion, and love.

The term "*Paranoid*" implies a sense of a hostile environment coupled with a tendency towards the formation of delusions of a systematised character to explain it.

A Delusion is a false belief which cannot be corrected by an

appeal to reason or logic. The education and environment must be taken into account in assessing whether a patient's ideas should be regarded as delusional or not. Primary (or autochthonous) delusions spring up suddenly with conviction but without previous warning, often in the setting of a peculiar tense emotional atmosphere. They are characteristic of early schizophrenia. Thus a schizophrenic became suddenly certain that the firing of cannon in Hyde Park to celebrate the King's birthday really foretold the end of the world.

Many delusions are secondary to hallucinations, but they can occasionally develop from a real event or experience as the result of systematic although emotionally biased reasoning.

Delusions are usually classified as delusions of grandeur, of self reproach, of poverty, of reference, of persecution, or as hypochondriacal delusions, according to their content.

Some schools of psychology try to explain their origin by invoking various psychological mechanisms. Delusions of grandeur, for example, are said to result from over compensation to feelings of inadequacy, insecurity, or inferiority. Self reproach is explained as incomplete or unsuccessful repression which leaves the feeling of guilt behind. Persecutory or paranoid ideas are said by some psychiatrists to represent the projection of repressed homosexual tendencies. Most authors however, would regard this last explanation as too restricted and would hold that any undesirable tendency or quality which could not consciously be endured by the individual may be projected and result in a delusion of persecution.

The recognition of these mechanisms, when they can be proved to exist in an individual case, may be of value as indicating how that case should be approached, but their wholesale assumption is unwise, and may prevent the investigator from seeing the really significant psychological connections in an individual case.

Indeed they are often a mere description in other terms, and it can frequently be demonstrated that a variety of different delusions may be equally well understood by invoking the same mechanism, which limits its value as an explanation of any particular delusion. For instance, although hypochondriasis may be explained as representing the flight from environmental or personal difficulties into illness, yet this explanation is too general, and does not account for the transition from a mere preoccupation with the bodily functions to definite delusional formation, such as that the bowels are blocked or that the organs are rotting away, or that the brain is liquefying, or that the body is dead (nihilistic ideas).

Obsessional Ideas (compulsive thoughts) must be distinguished from delusions and from predominant ideas. Compulsive thoughts are recognised as being abnormal and foreign to the personality, and are resented and resisted. The patient struggles against an obsessional idea, but fights for his delusions, and accepts or revels in his predominant preoccupation. In content, obsessional thoughts are often banal and pointless, but sometimes indecent, blasphemous, or aggressive formulations may be expressed.

Disturbances of Affect (or Emotion)—The disturbances may consist of variations in intensity or duration, or the emotional response may be abnormal because it is inappropriate in the particular situation. Some of the emotions met with in psychotic patients are of a kind either unknown in normal individuals, or only experienced by them in very special circumstances.

Intensity—Some patients show an increase in the intensity of their emotions at the beginning of an acute psychosis, others, however, complain of their poverty and loss of emotion (*affective loss*). This is common in depressions and in early schizophrenia. Again, certain quite normal individuals are acutely aware of complete emotional detachment after a psychic shock, such as seeing an accident. This is usually a transient experience of no significance. *Shallowness of affect* is frequently seen in imbeciles, schizophrenics and in demented. In so-called moral insanity (moral imbecility) the social sense is poorly developed or apparently missing.

Incapacity to control the emotions and their expression is characteristic of organic syndromes (*emotional incontinence and lability*). Normal emotional experiences, such as elation, depression, irritability, anxiety may become morbid by reason of their intensity and duration, but the extreme degrees of melancholy and panic are never experienced by the normal individual. *Ecstasy* may be described as a feeling of overwhelming bliss combined with an all-pervading sense of clearness of perception. It is often associated with a feeling of auspicion and fear, and not infrequently accompanied or followed by the appearance of autochthonous delusions. True ecstasy is probably beyond the experience or the imagination of normal persons. States of ecstasy are chiefly seen in schizophrenia.

Incongruity of Affect—This is also a frequent symptom of schizophrenia. By incongruity of affect is meant, for example, that the patient may refer with indifference to the most horrible experiences, or even jest about them.

Ambivalence denotes the simultaneous existence of contradictory emotions also frequently observed in schizophrenics

Disturbances of Memory—The function of remembering is generally divided into (a) Registration (b) Retention (c) Recall

(a) *Registration*—Registration of the material to be remembered may be disturbed by lack of concentration. Thus in manic states the distractibility of attention prevents the patient from perceiving properly what is happening. The manic patient will therefore tend only to remember subsequently those things that by chance or because of their special impressiveness did not escape his attention. In states of unconsciousness nothing can be recorded hence the subsequent amnesia. When consciousness is dimmed or clouded only a partial or patchy recollection of what has taken place remains. This may even extend to a complete amnesia if registration was grossly deficient.

(b) *Retention*—Disturbances of retention should only be assumed if it is certain that registration and recall are unaffected. Retention for short or longer periods of time (the latter being essential for learning) may be disturbed to a different degree. The capacity for retaining visual and auditory material may also differ markedly. In general the capacity to retain material is better if associations are present with which it can easily be connected. Poverty and slowness of association may simulate a memory disturbance.

(c) *Recall*—Recall may be either automatic or voluntary. In morbid mental conditions automatic recall is often preserved whilst the capacity for voluntary recall (i.e. involving conscious effort) is frequently impaired. These phenomena can often be observed in normal individuals who are fatigued or in the aged and the disturbance is most marked in trying to recall names. It is generally possible for a person to recognise something immediately which he could not recall on voluntary effort or only to be able to recall facts when something associated with them is recollected. Voluntary effort quite often seems to interfere with recollection. This fact which is known to everybody by self observation may be a prominent feature in the Korsakow psychosis. Thus such patients may be unable to recall things when asked to do so directly, but recall them readily if the problem is approached indirectly.

The ability to recall is facilitated by richness and rapidity of association consequently poverty or slowness of association may make memory disturbances appear more severe than they

really are. All disturbances of recall cannot, however, be explained as being due to loss of initiative or poverty of association. Nor should all memory disturbances be attributed to "repression," although this may play an important part in determining which material is forgotten, or rather which material cannot be recollected.

When memory impairment is due to organic brain disease, this is usually shown in memory for recent events rather than for remote ones. The gaps of memory, or amnesia, consequent upon sudden damage to the brain (head injuries, epileptic fits, apoplexies) are often for a longer period than that of the actual unconsciousness. This is frequently seen in *retrograde amnesia* after injury to the brain as when an individual cannot remember the accident or the events for a variable length of time preceding it. The amnesia for the period of unconsciousness, or of disturbed consciousness, is due to lack of registration. *Anterograde amnesia* (that is loss of memory for a period after consciousness has apparently been regained) is due to a state of altered consciousness during the period which the patients do not remember afterwards.

Total loss of memory over a long period, or over the whole of life, is generally a hysterical symptom, and inconsistencies between the knowledge which the patient shows and that which he claims to have forgotten may demonstrate that the repressed material is very near the surface of consciousness. In other words, deliberate deceit or a tendency in this direction, plays an active part.

A normal quality of remembering is that it tends to mould the past according to desire, and to fill in defects in memory with facts which may have been there rather than with facts which are genuinely recollected, and the conviction that such false recollection carries is often very striking. When there is a pathological loss of memory, the gap is often filled in with the most elaborate fabrications. Broadly speaking, the less critical the patient, and the more active his initiative, the more capable he becomes of producing such fabrications, and of changing them under cross-examination. This is often strikingly demonstrated in the Korsakow psychosis.

The feeling of familiarity which is experienced on recognition may also, in certain abnormal conditions, be attached to facts or things that have not previously been known to the individual. This experience of "*déjà vu*" is known to many normal persons when fatigued or sleepy, and it may be a prominent feature in certain neurotic syndromes.

In the Korsakow psychosis patients not infrequently get

the order of past events wrong, so that the disturbance is not so much a disturbance of correct fact as of correct sequence

The problem of time perception and its disturbances is still very obscure. Some patients complain that time moves too fast or too slowly, or in extreme cases that it seems to stand still, or rushes on so fast that they cannot follow

Disturbances of Intelligence — The variation in the amount and type of intelligence is very great. Low intelligence is the leading symptom of mental deficiency (see p 1006). An acquired disturbance of intelligence when irreversible is known as dementia. A moderate degree of deterioration may only be evident in an inability to adapt to new problems and situations whilst the capacity to cope with ordinary activities and familiar tasks is still preserved. Severe deterioration interferes with the adjustment to the ordinary activities of everyday life. As regards intellectual performances, creative thinking suffers first, abstract reasoning next, until finally primitive tasks such as the definition of words or the finding of opposites or common qualities becomes impossible. The lower the original intellectual level, the more difficult it becomes to determine mild intellectual impairment. In attempting to do this it is always necessary to try to assess the patient's previous level from the past history of previous performance and occupation. Tests for original intellectual level are based on the fact that a patient's vocabulary gives a fair idea of his intellectual and educational level, and that this indicator is relatively resistant to mental deterioration.

Disturbances of Sensation — Hallucinations — These may be defined as sensory perceptions (mental impressions of sensory vividness) without objective stimulus. An example would be seeing a pink elephant when no pink elephant was present.

Illusions are real perceptions falsified, an example being to mistake a dark stain on a pillow for a bed bug. These definitions may be accepted for practical purposes, but it should be borne in mind that normal sensory perception is far from being an objective picture of reality, but is conditioned and modified by many personal factors, both sensory and extra sensory. In other words there is always a personal contribution to a perceptual situation, but the amount of this personal contribution varies enormously. This holds true for illusions and hallucinations as well as for normal perceptions.

Some anomalies of sensation may be mentioned that should be separated from hallucinations and illusions in the stricter sense. Thus *distortions* of visual impressions, owing to detachment of the retina, noises in the ear or

labyrinthine sensations due to vascular disturbance, numbness or tingling in the extremities due to pressure on the peripheral nerves, all being disturbances of the apparatus of sensation, are better kept apart. The same applies to flashes of light, if produced by stimulation of the optic nerve, or the more complex subjective experiences produced by stimulation of the sensory areas of the cortex or cerebral pathways.

Visual hallucinations are most commonly found in states of impaired consciousness (delirium and twilight states) and should always suggest the predominance of an ætiological cause of an organic type. Some normal individuals however, experience visual hallucinations just before they go off to sleep (hypnagogic hallucinations). Epileptics in twilight states often complain of seeing red colours or fire, but their visual experiences may be more elaborate. Visual hallucinations in toxic and delirious reactions may range from kaleidoscopic patterns, which appear when the eyes are shut, to the most complex visions of scenes, persons, animals, and objects, either still or moving at various speeds. The impression may be vague, or very clear and detailed. The hallucinated objects may be projected in a real setting, i.e., a man may be seen sitting in a real chair, but may be transparent and uninfluenced by any physical happenings around him. Schizophrenics may experience symbolic visions, often possessing a quality of intense significance, but visual hallucinations in schizophrenic conditions are more usually in the nature of vivid mental pictures rather than experiences which are thought to be part and parcel of the external world, and, except in acute phases or episodes, are rare.

Auditory Hallucinations—These are most common in schizophrenic states, but also occur in toxic confusional conditions. They are usually localised in the head, but may appear to come from outside. Less frequently they are located in some part of the body, this is very typical of schizophrēma. They usually occur in the form of voices of varying distinctness and even when the exact words are not clearly heard, the general import is often felt to be plain. Sometimes the schizophrenic patient recognises them as his own thoughts, made audible to him simultaneously, or anticipating or repeating what he is thinking. Noises, such as creaking, shooting, ringing, and so on, may also be heard. Auditory hallucinations often have an illusional foundation.

Tactile Hallucinations—Tactile hallucinations are described by schizophrenic and delirious patients. The patient may feel he is being touched or blown upon, or they may take the

form of a drizzling sensation of sand or dust. The genital organs are often the seat of tactile hallucinations, which may be elaborated into a belief that the patient has been the victim of rape. Some schizophrenic patients feel that their body, or parts of it, has changed in size or weight. Statements about a change in the internal organs, such as that the heart has become a stone, or that the bowels are blocked, may be metaphorical expressions, but are sometimes accepted later as statements of fact, and, in so far as this is the case, become delusions.

Olfactory Hallucinations—Olfactory hallucinations, which always seem to have an unpleasant character, are frequently complained of by schizophrenics, less frequently by involutional melancholics, and occasionally by delirious patients.

Hallucinations have many points in common with sensory perceptions, but they also possess certain distinguishing qualities, quite apart from the absence of appropriate stimulus. Their perceptual character, or the conviction that they represent something of external origin, varies from case to case. Zucker has made experiments by trying to imitate a particular hallucination to see whether the patient could distinguish between their hallucination and the real perception of the attempted imitation. He found that, with the exception of certain toxic and delirious conditions, they could distinguish between the two quite readily. Hallucinations appear to be more obtrusive in character than perceptions, and tend to occupy the foreground of the patient's mind, and to absorb his attention. Otherwise the fact that patients are unable to disregard voices and other sensations that are practically meaningless could not be explained.

The content of the hallucinations is determined to a varying extent by the past history of the patient concerned. Elementary hallucinations are more easily explained on a neurological level, but more complex hallucinations of visions and voices can often be traced, as regards content, to the previous experiences, attitude, views and fantasies of the particular patient. It is sometimes possible to distinguish the physiological from the psychological element in their production. Thus, delirium tremens patients usually see small and moving dots, as do patients with small scotomas. Their elaboration into rats, mice, or something else depends upon extra sensory factors. Similarly, more complex hallucinations of cocaine addicts (cocaine bugs under the skin) are built around the nucleus of their tactile sensations. In other instances it is not easy to discover a sensory element in the development of

hallucinatory experiences, or any illusional basis, and it may be preferable to interpret these experiences in the same way as dreams, but no analysis of a biographical type can explain the fact that hallucinations occur at all. In order to explain this it is necessary to introduce factors that are not of a psychological type.

Depersonalisation—Depersonalisation is "a state in which the individual feels himself changed throughout in comparison with his former state. This change extends to both the patient and the outer world and leads to the individual not acknowledging himself as a personality. His actions seem to him automatic, he observes his own actions like a spectator. The outer world seems strange to him, and has lost its character and reality" (Paul Schilder).

The sense of the outer world being changed is sometimes known as *derealisation*, as opposed to the feeling that the patient is himself changed, which constitutes depersonalisation in the more strict sense. Depersonalised patients complain of loss of feeling, whereas observation of their behaviour shows natural emotional responses. There are, however, cases when the subjective poverty of emotions is followed by objective affective loss.

PSYCHIATRIC SYNDROMES (REACTION TYPES)

It is essential to remember that psychiatry deals with individuals, and hence with *individual* reactions as varied as the nature and experiences of different individuals can make them. Consequently, as Adolf Meyer has pointed out, the problem of mental disorder is not exhausted by the attempted erection of categories of "disease entities" into which patients can be pigeon holed from a diagnostic point of view.

The question to be asked about a psychiatric patient is not, therefore, "What kind of mental disease has this patient got?" but rather, "What type of reaction does this *individual* show, and how can we understand it?" And we can only understand it by studying the *individual*, his *history*, and his *environment* from many angles.

In modern psychiatry, therefore, the older conception, taken over from general medicine, of rather rigid and clearly defined "disease entities" has been replaced by the broader and more elastic conception of "reaction types" or "psychiatric syndromes", for, although an infinite number of individual varieties must be recognised, certain broad patterns of morbid response can be discerned.

A *syndrome* is a complex of symptoms that tend frequently to be found in association

Thus, catatonic symptoms are not evidence of a disease "catatonia," but are symptoms that may, for example, be seen in organic types of reaction, and also, much more frequently, in schizophrenic types of reaction

There is often considerable overlapping of the various syndromes, so that one or more symptoms may be common to several types of mental disease

Psychiatric Classification —It was not infrequent in the past to consider the neuroses as quite distinct from the psychoses. This sharp distinction is erroneous in theory and misleading in practice. In the classification that follows the neuroses are included as subdivisions of one of the three main groups

1 The Organic Reaction Type —The main features are disturbances of consciousness and dementia. Organic factors are of predominant importance in the production of this type of reaction which may be subdivided into clouded consciousness, delirium, Korsakow syndrome, hallucinosis and twilight states, and dementia

The various organic causes which may result in the development of these subdivisions of the main organic reaction type will be discussed later

2 The Schizophrenic Reaction Type —The main features are progressive introversion, splitting of personality and paranoid symptoms. The meaning of these terms will be discussed later. This reaction type occurs mainly as the result of the operation of constitutional factors, and may be subdivided into simple hebephrenic catatonia, and paranoid varieties

3 The Affective Reaction Type —The main features are swings of mood or abnormal mental and physical reactions to emotions, or both combined

Constitutional or psychological factors or both, are usually predominant in the production of this reaction type, which may be divided into manic and depressive states, anxiety states, and hysterical and obsessional reactions

SCHEME OF EXAMINATION

It is just as important in psychiatry as in general medicine to have a scheme of examination, for unless a systematic scheme of examination is followed, important aspects and problems may be missed

It must, however, be remembered that in psychiatry a

good deal of elasticity is necessary in following such a scheme. For it is not only essential to try to establish a satisfactory contact (*rapport*) in the course of the examination, but the examiner must also attempt to gain an impression of the total personality of the patient.

The following items are suggested: Name, age, sex; single, married, divorced; occupation; addresses of patient and often also of correspondents, employers, doctors, relations; telephone numbers. Details of *complaint* and careful chronological *history of present illness*, obtained from patient and friends. Importance of independent accounts. See relatives first and separately.

Personal History.—History of early development; birth injuries, dates of walking and talking; neurotic traits such as fear of the dark, stuttering, thumb sucking, nail biting, enuresis, sleep-walking, nightmares. Sleeping arrangements. School record. scholastic attainments, keenness in games, sociability, homesickness. Work record. jobs held, why taken on, how long held, reasons for leaving, financial returns. Past health. previous physical diseases or attacks of mental ill health or "nerve" trouble. Effects of medical contacts, use and abuse of drugs, attitude towards health matters and bodily disturbance. Social and sex attitude towards relations and friends. Sex information and development. sexual experiences, menstruation, menopause, marriage, pregnancies, contraceptive measures.

Interests, hobbies, ambitions. Legal difficulties including early tendency to lying or stealing. Religious and political tendencies. Fads and physical culture notions. Successes and disappointments, difficulties and quarrels. How spare time is employed, what makes life worth living.

Personality Traits.—Actions and attitudes indicating that patient was *sensitive, shy, reserved, solitary, shut-in, day-dreamer, sociable, active, friendly, affectionate, adaptable* or *not, stubborn, obstinate, suspicious, jealous, frank, moody, restless, dissatisfied, irritable, impulsive, cheerful, anxious, apprehensive, conscientious, neat, orderly, meticulous, efficient, cruel, stingy, hypochondriacal, eager to have sympathy, "martyred," aggressive, submissive, a leader, a follower, self-confident, apt to feel inferior, religious, ethical, moral, interested in the abstract and in "right and wrong."*

Family History.—Nervous and mental illness, epilepsy, alcoholism, drug addiction, personality traits of relatives. Moodiness, seclusiveness, successes, failures. Suicides. *Hospitalisation.* Social and cultural standing.

Mental Status.—(a) *Appearance and Behaviour*. *Rapport,*

facial and bodily expression, condition of hair and clothing, postures, gestures, tics, grimaces Fear, restlessness, agitation, spontaneity in speech and action

(b) *Talk* The form of the patient's utterances rather than their content is here considered Does he say much or little, talk spontaneously or only in answer, slow or fast, hesitantly or promptly, to the point or beside it, coherently, discursively, loosely, with interruptions, sudden silences, changes of topic, comments on happenings and things at hand, appropriately, using strange words or syntax, puns? How does the form of his talk vary with its subject?

(c) *Mood* The patient's appearance may be described, so far as it is indicative of his mood His answers to "How do you feel in yourself?" "What is your mood?" "How about your spirits?" or some similar enquiry should be recorded Many varieties of mood may be present—not merely happiness or sadness, but such states as irritability, suspicion, fear, unreality, worry, restlessness, bewilderment, indifference, and many more which it is convenient to include under this heading

Observe the constancy of the mood the influences which change it, the appropriateness of the patient's apparent emotional state to what he says

(d) *Delusions and Misinterpretations* What is the patient's attitude to the various people and things in his environment? Does he misinterpret what happens give it special or false meaning, or is he doubtful about it? Does he think anyone pays special attention to him, treats him in a special way, persecutes him or influences him bodily or mentally, in ordinary or scientific or supernatural ways? laughs at him? shuns him? admires him? tries to kill, harm annoy him? Does he deprecate himself in any way his morals, possessions, health? Has he grandiose beliefs?

(e) *Hallucinations and other Disorders of Perception* The source vividness, reality, manner of reception, content and all other circumstances of the experiences are important, its content, especially if auditory or visual, must be reported in detail When do these experiences occur, at night, when falling asleep, when alone? What is the patient's own explanation? Any peculiar bodily sensations, feelings of deadness?

(f) *Compulsive Phenomena* Obsessional thoughts inclinations or acts Are they felt to be from without or part of the patient's own mind? *Relation to his emotional state* does he repeat actions unnecessarily, such as washing, to reassure himself? Phobias and anxiety

(g) *Orientation* Record the patient's answers to questions about his own name and identity, the place where he is, the time of day and the date

(h) *Memory* This may be tested by comparing the patient's account of his life with that given by others, or examining his account for intrinsic evidence of gaps or inconsistencies. There should be special inquiry for recent events such as those of his admission to hospital and happenings in the ward since, or his journey to hospital or consulting room. Selective impairment of memory for special incidents, periods, recent or remote happenings

Record the patient's successes or failure in grasping, retaining and being able to recall spontaneously or on demand, three or five minutes later, a number, a name and address, or other data. Give the patient a short story to read and ask him to repeat it in his own words. Give him digits forwards and then backwards and record how many he can repeat immediately after being told them. A normal person should be able to repeat at least seven forwards and five backwards.

(i) *Concentration* Subtraction of serial sevens from a hundred (give answers and time taken). Telling the months of the year forwards and backwards.

(j) *Grasp of General Information* Tests for general information and grasp as well as for ability to calculate should be varied according to the patient's educational level, and his experiences and interests. Suitable questions are —

Name of the King, and his immediate predecessors

The Prime Minister

The Chancellor of the Exchequer

Capitals of France, Germany, Italy, Spain, Scotland

Six large cities in Britain

Date of beginning and end of the last War

These tests are not intended so much to estimate general intelligence as to see whether there has been any falling away from the patient's former presumptive level of knowledge and capacity, which has to be estimated from his life history and independent information.

(k) "*Intelligence Tests*" Will be dealt with later in the special section on Mental Deficiency, see p. 1007. A simple story may be told in order to test whether the patient grasps its point.

Specimen Story — *The Donkey Loaded with Salt* A donkey, loaded with salt, had to wade a stream. He fell down, and for a few minutes lay comfortably in the cool water. When he

got up he felt relieved of a great part of his burden because the salt had melted in the water. Longears noted this advantage, and at once applied it the following day, when loaded with sponges, he again went through the same stream.

This time he fell purposely but was grossly deceived. The sponges had soaked up the water and were considerably heavier than before. The burden was so great that he succumbed.

The same remedy does not apply to all cases.

Definition of abstract words e.g. What is envy? Surprise? or explanation of proverbs e.g. The early bird catches the worm or differences e.g. dwarf and child idleness and laziness.

(1) '*Insight*' This is best obtained by the questions as to whether the patient regards himself as being ill what he regards as being the nature of his illness (whether physical or 'nervous' or both) and whether he thinks he will get well.

TREATMENT

General Medical Treatment—The treatment of the various conditions of physical disorder and disease that may be relevant to psychiatric problems must be sought elsewhere and the more specific forms of treatment that are now employed for special forms of mental disease (e.g., insulin in schizophrenia) will be dealt with later in the appropriate sections.

Only some general methods of symptomatic treatment that are applicable in many conditions without reference to the special type of the reaction or its aetiology will be considered below.

Drugs—Drugs are mainly used to decrease anxiety, agitation, restlessness and excitement and to procure sleep.

For acute excitement and restlessness, hyoscine ($\frac{1}{10}$ to $\frac{1}{5}$ gr) combined with morphia ($\frac{1}{2}$ to $\frac{1}{4}$ gr) can be very valuable, but it must be remembered that hyoscine produces dryness of the mouth and anaesthesia (with its effect upon respiration) and hence great nursing care is necessary.

Continuous narcosis may be indicated in states of prolonged agitation and excitement. The object of this treatment is to keep the patient asleep for sixteen to twenty-two hours a day, for a period of from five to ten days. The technique employed varies in different centres but usually Somnifaine (2 to 3 cc b.d.) is given by intramuscular injection at 9 A.M. and again between 4 and 7 P.M. When necessary, paraldehyde is given

in the interval, either by the mouth or by rectum. The times just before the injection, when the patients are relatively awake are used for nursing care (bowels, food and fluid, temperature, blood pressure, urine examination etc.) It is essential that the patient should receive sufficient nourishment and that it should possess the necessary caloric value.

Continuous narcosis is not a form of treatment that should be undertaken without previous practical experience. It has very great value in many of the acute reactions of war time.

For lesser degrees of anxiety and restlessness bromides may be of value, but the danger of bromide intoxication should always be borne in mind, as this may occur even with small doses if continued for a long time, especially in elderly or arteriosclerotic patients. Bromide and chloral hydrate is an excellent combination, the latter is an excellent sedative and hypnotic, and is not cumulative in its effects. The barbiturates are also of value in states of tension. Barbitol (veronal) given in divided doses of $2\frac{1}{2}$ gr b d or t d s, often gives relief if the state of anxiety or tension is not too severe. Some patients also find the barbiturates useful to fortify themselves when likely to be confronted with a difficult situation.

Opium may be given, under careful supervision, for endogenous depression with much anxiety.

For sleeplessness paraldehyde, were it not for its unpleasant taste and smell, would be the ideal hypnotic, for it is safe, powerful and acts quickly. It can be given by mouth in 2 drachm doses or 4 drachms by rectum. Many of the barbiturates are also excellent, perhaps Luminal ($\frac{1}{2}$ to 2 gr) and Medinal (5 to 10 gr) are the most commonly used.

It is important to give barbiturates in sufficient doses and to be ready to change them if individual intolerance is shown, and it is often wise to combine them, i.e., to order one that induces sleep rapidly with another that has a more prolonged effect (Evipan and Nembutal plus Veronal or Luminal).

In prescribing hypnotics it is, of course essential to discover whether the trouble lies in going off to sleep (as in anxiety states) or in waking up early (as in a depressive state), or in both (as in mixed states) and to prescribe accordingly.

Bromide is not a hypnotic, but may help to induce sleep by decreasing worry and restlessness.

Sodium Amytal has great interest in the treatment of stupors and after a suitable intravenous dose (0.5 gm) patients who have been mute and resistive for weeks and months will often begin to talk spontaneously, to answer

questions, and to carry out orders. With larger doses, patients fall asleep after a period of responsiveness, hence daily injections of the drug have been suggested with the hope of combining the benefit of a continuous narcosis with periods of accessibility that might be utilised for psychotherapeutic purposes.

It is difficult to assess the results that have been claimed, but certainly there is some danger of the development of epileptic fits after a sudden withdrawal.

Benzedrine (5 to 20 mgm) has been used as a direct stimulant in patients with lassitude, depression, and retardation.

General Management and Nursing Care—Cases of major psychoses especially when acute should be confined to bed. Milder degrees of tension and restlessness also frequently respond well to this simple measure. Continuous baths at body temperature are indicated in severer forms of restlessness and excitement, though some now question their usefulness.

Padded rooms or cells are seldom used in modern mental hospitals, but were formerly employed in cases of severe excitement not otherwise controllable. It could be urged that they had a definite value for a certain type of case, and perhaps would still be used were it not for their unfortunate appearance and reputation.

It is often advisable to treat patients in single rooms rather than in large wards, for certain depressed patients are distressed by the noise made by other patients, and excitable patients are unduly stimulated and distracted by company. Separation, however, makes supervision and observation more difficult, and the treatment of suicidal patients in single rooms demands a large staff.

The ingenuity and inventiveness of *potential suicides* can never be overestimated. Some of the dangers can be guarded against by suitable planning and construction of the building, and by the adoption of certain measures in ward routine, but strict and constant supervision, combined with knowledge of the individual patient, are probably the most effective measures. *Refusal of food*, or of sufficient food is common in mental disorders and may be a disguised form of suicidal attempt. If it is impossible to induce the patient to take sufficient nourishment by other means, recourse should be had to tube feeding without undue delay. Certain patients who do not refuse food entirely, underfeed themselves systematically. It is essential to keep an exact weight chart and, if necessary, to start tube feeding should the weight continue to drop.

again and again. After admission, the greatest care should be devoted to the question of which ward the patient should be in, or whether he would be better in a single room, and as to whether he is influenced in a favourable or unfavourable way by another patient, or by a particular nurse. In brief, the reaction of the patient to his environment must be studied most carefully, and the desirable alterations made in so far as that is possible, and it is possible to a surprising extent.

Occupational Therapy, which is of cardinal importance in the treatment of mental disorder, is based on the elementary principle that it is a good thing for everybody, including patients, to have something to do. The name is perhaps unfortunate as tending to emphasise the aspect of filling in time, whereas stress should be laid on the far more important aspects of relieving unhappiness or discomfort by distraction, affording an opportunity for the recovery of real pleasure in activity, increasing self confidence by tangible evidence of a capacity that had been doubted, and often enough frank training in better habits of concentration and work.

Patients suffering from mental disorders often experience difficulty in making decisions, lack self confidence and initiative, and show a loss of interest, except perhaps in their own symptoms. To ask such patients to plan their day, and to fill in their time as they think best, is not merely to ask something that is stupid and unfair, but it is to permit something that may be positively harmful.

Consequently, a carefully planned day, with facilities for the development and enjoyment of as many interests as possible, should form an essential part of the life in every modern mental hospital, and the same principle of careful individual planning of the best "twenty four hour day" that can be worked out should be applied to psychiatric patients who are not in mental hospitals.

"Occupational therapy" is not achieved by suggesting a little knitting as an alternative to brooding, or the depressing comparison of rival discomforts with other patients. It should be definitely organised, thus, for example, patients should be made to go to "occupational classes" for various handicrafts. But games and entertainments are just as much a part of an occupational scheme as raffia work or carpentry, and there are other forms of valuable, practical, and interesting activities besides indulgence in the arts and crafts.

Environmental Adjustment and Social Work—In the treatment of out patients, as well as in hospital cases, a great deal may be accomplished by "social work" of various kinds.

The assistance of trained social workers is of the greatest value for this purpose and many of the activities of a good general practitioner are essentially of this nature. All practitioners would be wise both to acquaint themselves with and to avail themselves of the social service facilities in their neighbourhood such as welfare organisations clubs and recreational opportunities.

It is necessary to establish contact with relations friends and employers in order to get to know, and if possible to adjust conditions both at home and at work in a more satisfactory manner not infrequently as much can be done by explanation and advice to those with whom the patient lives or with whom he comes into contact as by a more direct approach to the patient himself.

Minor Psychotherapy—In many instances quite simple explanation and discussion of the problems and of the nature and origin of the illness may effect great improvement. The patient may be given direct advice so far as certain personal and social difficulties are concerned but it is preferable to do this indirectly by helping the patient to make his own decisions. Sexual problems at the time of puberty or after marriage or fears of pregnancy and subsequent neurotic reactions can frequently be dealt with by explanation and instruction or by referring the patient to a birth control clinic.

The suggestive influence of the personality of the doctor and of the atmosphere of the hospital or consulting room are factors that are difficult to assess in any kind of medical treatment. Deliberate use can be made of these influences in treating minor psychological troubles. So called indirect suggestion by means of the electric current or inert medicines is not a very desirable way of carrying out psychological treatment but it can be very effective and if it is done conscientiously and followed up by or combined with explanation and reassurance or whatever may be necessary it may be a time saving method.

Persuasion though sometimes thought to be a method of influencing the patient by reasoning always contains a large element of suggestion.

The most striking method of treatment by suggestion is hypnosis which is a sleep like state in which the contact between physician and patient (rapport) is not interrupted. A person in a hypnotic state is particularly susceptible to suggestion and it is possible by hypnosis to influence many physical and mental functions that are not within the control of the will.

It is not possible to detail here the various methods of inducing a hypnotic state, but it must be remembered that only a proportion of mankind can be hypnotised. The therapeutic application of hypnosis is limited even for these. It is, however, an excellent method of removing hysterical symptoms, such as blindness, aphonia, pareses or amnesia. The removal of a hysterical gut in a single session provides one of the most striking successes that a psychotherapist can have. Some patients otherwise refractory to hypnosis can be readily hypnotised after a moderate dose of a hypnotic. A further development is the production of a drowsy suggestible state by the administration of evipan or sodium amytal intravenously. This 'narco analysis' has proved particularly useful in the clearing up of psychogenic states of loss of memory.

Major Psychotherapy—The more complex abnormal mental reactions constitute the main field of major psychotherapy.

Neurotic illnesses of long standing always tend to become increasingly complex, for with the passage of time, neurotic reactions give rise to new problems, which again become the source of new conflicts and difficulties. The task of trying to achieve continued readaptations to difficult circumstances often necessitates changes of attitude and sacrifices of desires, ambitions, and convictions. This may result in conscious inconsistency and strain or repression and self-deception.

Conflicts involving deep-seated religious, moral, and social standards are not likely to yield to suggestive therapy or environmental adjustment in highly differentiated individuals and may therefore demand more prolonged psychological treatment.

Strangely enough, psychotherapists have separated themselves from the rest of psychiatry, and occupy a position to which there is no equivalent in any other branch of medicine—haemotherapists, or perhaps rather ferro-haemotherapists are unknown. This may have arisen partly owing to the large amount of time and concentration required for prolonged psychological treatment but is probably mainly due to the formation of special psychotherapeutic schools, each of which has developed not only a technique but a doctrine of its own.

Psychoanalysis, based on Sigmund Freud's pioneer work on the study of the individual neurotic patient, has outgrown its character as a method of treatment, and has become a school of philosophy and psychology, whose pupils also carry out psychotherapy, but only according to the strict rules of their order. The ideas of Freud, whether accepted or rejected, have given a great stimulus to psychiatric work. Their

therapeutic application must be studied in the books of the master and his pupils, and the real technique is only available to the formally initiated. It is difficult to assess the results that have been claimed, for so few have been published, but they do not seem to be better than those achieved by less laborious and expensive methods.

The schools of Adler and Jung are offsprings of the Freudian psychoanalysis, whose legitimacy is not accepted by the parent. The student who takes a special interest in them must also be referred to the larger textbooks, but would do better to consult the works of those authors themselves.

The psychotherapy of the neuroses should always be based on some general principles, which can merely be outlined here very briefly. Psychotherapeutic technique can be learnt as little from books as can surgical technique.

The first step in any form of psychotherapy must be to obtain a careful and detailed history. It is essential to collect information from all possible sources, such as relatives and friends, in order to supplement and to correct the account given by the patient himself. The collection of facts should precede attempts to interpret them, and the elucidation of the more fundamental problems that lie behind the overt complaint or complaints is only possible in the light of these facts. At the same time it must be borne in mind that good history taking inevitably involves therapeutic work. The opportunity of talking about intimate matters to an impartial witness is often felt as a great relief. The interviews with the doctor leads the patient to a more systematic survey of his difficulties. He has to formulate his problem in words, and by this very process they often become more clear, and can be viewed more objectively.

It is often possible, during even the preliminary period of history taking, to remove at least some of the manifest symptoms by reassurance, suggestion, or other form of symptomatic treatment, and this may enable the patient to face his other difficulties and problems with greater ease.

It is useful to have in mind a list of important topics in order to arrange in a systematic manner the material that must be collected in a more detailed analysis of the patient's personality. Diethelm suggests the following headings —

- 1 Intellectual resources
- 2 Emotional tendencies and temperament
- 3 Volition and action tendencies, interests and strivings
- 4 Standards
- 5 Attitude to the body and to the instinctive desires

- 6 Attitude to material needs
7. Attitude to oneself and ability to deal with oneself
- 8 Social needs and adjustment to the group
- 9 Assets and handicaps and personality synthesis

There are various methods of ascertaining and of making the patient aware of the psychological factors which, for his own good reasons, he has removed from the centre of his consciousness. The choice as to whether hypnosis, free association, and dream analysis are used to supplement systematic questioning will depend upon the personal technique of the physician, on the nature of the particular problem, and upon the necessary economy of time.

The more active part of treatment begins with the explanation and interpretation of the symptoms. These, if possible the patient should be guided to find and elucidate for himself. He is thus gradually led to a more just appreciation of the true nature of his problems and as to how they arose, and it is well to try to discover potential assets that have not been properly utilised, and not only to dwell on the mistakes that have been made or the deficiencies that have been shown.

Some schools of psychotherapy teach that the mere disentanglement of the origin of difficulties has a curative effect. Lack of therapeutic success is ascribed to lack of depth of the analysis, and thus leads to attempts to find the "essential" cause in the increasingly remote past.

This "buried treasure" school of psychopathology, the simple faith in the original psycho-trauma which explains all and which, if unearthed, leads to cure, is, in its extreme form, a small one, but in modified forms, it is perhaps still all too common. It must always be remembered that the psychologically comprehensible is not necessarily the same as the causally significant (see p. 971), and that understanding of the remote past does not necessarily confer control of the present. The majority of experts agree that another synthetic and constructive part of treatment has to follow. To gain a more just appreciation of the origin and the nature of the problems and to be able to assume a more detached attitude towards them means some progress, but in order to solve them more is needed. The majority of patients need to develop new attitudes and new ways of attacking their difficulties before they can deal with their particular situation.

Only a minority of patients, or indeed of mankind, are able to develop a philosophy of their own, and, therefore the majority are more willing to accept a ready-made system and

faith These are offered not only by religion but by the various schools of psychotherapy and their adherents The rapport developed in the course of prolonged psychotherapy often makes the patient accept the views and attitudes of his physician be that intended or not It must be the final object to loosen the patient's attachment again to such an extent that he is able to adopt his new insight and philosophy as truly his own and to stand on his own feet

For further information *Treatment in Psychiatry* by Oscar Dethelm, New York 1936 (MacMillan Co) is recommended

CONSTITUTIONAL ANOMALIES

Personality, as that term is used here, comprises both intelligence and character The personality of the patient is a very important factor both in producing and in colouring abnormal mental states Instincts are the driving forces that play an important part in determining the type of personality Anomalies in this sphere are therefore responsible for many anomalies in the make up of the individual

It is possible to outline only a few types of anomalies of instinct and of abnormal characters liable to become psychiatric problems Our knowledge of intellectual deficiency (mental defect) is more advanced This is no doubt partly because the practical importance of the problems raised by mental defect is more obvious and striking

Anomalies of Instincts—Although anomalies of the sexual instinct are probably the most frequent it must not be forgotten that anomalies in other instincts such as that of self preservation may also be found Thus there are families in which a large proportion of the members die by their own hand It is difficult to attribute this fact entirely to family example and family tradition important though these may be It seems more reasonable to assume that in such families the self preservative instinct is constitutionally weak

Sexual Anomalies—The student should have some knowledge of normal sexual development and of the intensity fluctuations and variations of the sexual instinct in order to form an opinion about anomalies of time of onset frequency and type of sexual activity and only very gross departures from what is statistically frequent should be regarded as abnormalities from the medical standpoint

Sexual immaturity is the most common sexual anomaly which though seldom calling for medical treatment in itself

can frequently be shown to be the foundation of many types of sexual maladaptation which do call for medical advice

Masturbation is a normal transitional stage of sexual development, but its persistence is often a symptom of immaturity. The incapacity to find a sexual partner may be only an expression of general developmental retardation. Similarly, frigidity in women is often a sign of, or results from, constitutional immaturity. The lack of desire for children may be due to the same cause. The underdevelopment of the secondary sex characters often suggests the constitutional origin of these psychological manifestations.

The importance of constitutional factors in the production of homo sexuality varies greatly. Homo sexual tendencies may often be observed in various members of the same family. It may be found in men with a feminine physique or in women with a masculine physique. On the other hand, many individuals who previously showed no evidence of homo sexual tendencies, indulge in homo sexual practices when placed in special circumstances, such as on board ship, or in prison. Such individuals have clearly been influenced by example and seduction. Homo sexual practices are not therefore the criterion of a homo sexual constitution and the fact that the majority of homo sexual prostitutes are hetero sexual subjects proves this very strikingly. Again, many constitutional homo sexuals never indulge in homo sexual activities, in the strict sense for fear of the legal or social consequences.

The typical homo sexual is soft natured sensitive and shy, and his "mother fixation" which is sometimes alleged to be the cause of his homo sexuality, may be regarded as one feature of his character. The homo sexual may show feminine traits, both in physique, gesture, and in his interests.

The attraction to the same sex often seems to spring from the enthusiastic friendships so characteristic of the age of puberty, and when the relationship remains on this level, whether intentionally or unconsciously, most valuable and permanent friendships may result. But when abnormal sexuality is repressed or when manifest conflicts with public opinion threaten, neurotic reactions often develop which bring the individual to the psychiatrist. It is not possible to describe abnormal sexual practices in detail though they are of interest here because they so frequently possess a constitutional background. The majority of them (exhibitionism, sadism masochism and so on) can be regarded as exaggerations of normal sexual features that become evident when the development of inhibitions and adaptation does not reach its ordinary level.

These anomalies come under the care of the physician when they give rise to conflicts with society, or if they become perversions i.e. when they dominate the sexual life instead of being part of it. It is a gross mistake to regard as perversions normal manifestations of sex. Thus to speak of infantile sadism and exhibitionism leads to wrong conceptions.¹

Abnormal Characters—The *schizoid* character is not a uniform type. The abnormal characters found in the families of schizophrenics (which is the original meaning of the term *schizoid*) comprise shy, introverted, and secluded characters, nature loving abstract minded, and idealistic, as well as cool ruthless remote, and egotistical individuals, and many of the queer, eccentric, and odd. The dreamy, bearded, be sandalled denizen of Bloomsbury or Montmartre is often a *schizoid* just as much as is the wild eyed fanatical adherent of some political or religious sect. Paranoid features, either of the more aggressive or the more passive kind, are also common. There is some positive correlation between *schizoid* characters and an asthenic or athletic physique.

Cyclothymic (cycloid) personalities frequently occur in the families of manic-depressives. They are extraverted, good natured, sociable, and adaptable. There is a strong positive correlation with the pyknic build. "the 10 in neck in a 14 in collar"

An excitable, aggressive character is sometimes seen in epileptic patients and it has therefore been suggested that these personalities should be called "epileptoids." The relationship to this disease is, however, much less close than in the other two groups, and it seems preferable to speak of excitable or explosive types. These personalities are common in certain families, and may have a considerable importance in psychiatric practice, for criminality, suicide and psychogenic reactions of various kinds often develop on this constitutional background.

The *hysterical* character should be clearly distinguished from hysterical (conversion) symptoms, for they may be observed independently of one another. The cardinal feature of the hysterical character is the desire to appear more than he (or more frequently she) really is, with which is coupled a striking skill in self deception. Hysterics are generally easily influenced by persons or ideas that appeal to them and they have a remarkable capacity for identifying themselves with others, and for imitating them. Their emotions are easily

¹ A good introduction is "Psychology of Sex" a Manual for Students Havelock Ellis. William Heinemann London 1934

roused, and they express their willingness to dedicate themselves to various ideals, until their enthusiasm changes for something else, which they then take up with the same conviction. The instability of their emotions, their vivid fantasy, and the adaptability of their minds make them untruthful and unreliable, although subjectively they feel quite candid, deceiving themselves much better than they usually deceive others. They are immature in their thinking and in their emotional reactions, and the sexual frigidity, which is very frequent, may be another expression of the same fact. They are often incapable of permanent affection or sexual relationships, but they are good short time flirts and know how to dally with the other sex to satisfy their vanity. Hysterical conversion symptoms often provide the means by which they try to dominate their surroundings with varying degrees of success.

The *obsessional* (anancastic) character is not always traceable in the history of patients with obsessional neuroses, and obsessional traits are often found in the early history of patients suffering from other types of abnormal mental reaction. Obsessional features are usually described as including excessive cleanliness or tidiness, pedantry, conscientiousness, and inconclusive ways of thinking and acting. It is only when these are accompanied by the feeling of subjective compulsion that they become obsessional symptoms. The exaggerated concern with the regularity of the bowels or other excretory functions accounts for the name 'anal-erotic' given to this type of character by the Freudian School. The obsessional character, as such, rarely gives occasion for psychiatric interference.

The most common, but most vaguely defined abnormal character is the *unstable psychopath*, perhaps better described as the "inadequate" person. The most prominent features are poverty of will power and determination, and this is generally shown best in the careers of such creatures. They are as debris upon the sea of life, floating from job to job and frequently submerged. It is striking to see how they can improve under strict guidance, not rarely under the thumb of a suitable wife. Unstable individuals of this type are candidates for all sorts of psychogenic reactions and they often come under psychiatric observation because of suicidal attempts. They fill the ranks of minor criminals and prostitutes. They are often asthenic in physique and get easily tired on physical effort, their emotions do not go very deep and change easily.

It is perhaps worth mentioning that bodily anomalies frequently coexist with the psychological anomalies in these

abnormal characters and all the so called nervous symptoms, such as tremor, restlessness, profuse sweating, vaso motor lability with blushing and fainting, and an allergic disposition are frequently found combined with the psychopathic anomalies, though detailed correlations have yet to be made. The same is true as regards morphological anomalies, often called stigmata, asthenic build, disproportion in physique, under development of the secondary sexual characters, or hetero sexual features.

MENTAL DEFICIENCY

Mental deficiency means intellectual defect existing from birth, or from the early years of life. Legally it is defined as "a condition of arrested or incomplete development of mind existing before the age of 18 years, whether arising from inherent causes or induced by disease or injury." *Amentia* is a term used as a synonym, *dementia*, as opposed to it means intellectual defect acquired later in life. Though mental deficiency should be clearly distinguished, on principle, from psychopathic anomalies, there is no doubt that the vast majority of defectives also show anomalies in the sphere of emotion, volition, and instincts. On the other hand a low intellectual level, even if not reaching legal deficiency, is always a serious complication of mental instability.

Mental defectives are usually graded, according to their intellectual level, as idiots, imbeciles, and feeble minded persons (morons). The following legal definitions are useful and sufficient for all practical purposes —

1 *Idiots* — "Persons so deeply defective in mind from birth or from an early age, as to be unable to guard themselves against common physical dangers."

2 *Imbeciles* — "Persons in whose case there exists from birth or from an early age mental defectiveness not amounting to idiocy yet so pronounced that they are incapable of managing themselves or their affairs, or, in the case of children, of being taught to do so."

3 *Feeble minded or Morons* — "Persons in whose case there exists from birth or from an early age mental defectiveness not amounting to imbecility, yet so pronounced that they require care, supervision and control for their own protection or for the protection of others, or, in the case of children that they by reason of such defectiveness appear to be permanently incapable of receiving benefit from the instruction in ordinary schools."

4 *Moral Imbeciles* — "Persons who from an early age

display some permanent mental defect coupled with strongly vicious or criminal propensities on which punishment has had little or no deterrent effect

Low grade defectives constituted by groups 1 and 2 above very frequently show in addition physical abnormalities and a large variety of neurological symptoms. Apart from mis-turbation idiots rarely show any sexual activity. This is of interest with regard to the question of their sterilisation.

Intelligence tests devised to grade normal and subnormal intelligence are based on Binet Simon's method or standardised against their scale. The Binet Simon test consists of groups of questions arranged for years of age and standardised in such a way that a normal child is able to answer all the questions of his age group. The extent to which the patient answers the questions correctly determines his Mental Age (M.A.). The M.A. divided by the actual age of the child and expressed as a percentage gives the Intelligence Quotient (I.Q.). An I.Q. between 90 and 110 should be regarded as normal.

There are many modifications and revisions of the original test, non verbal (performance) tests have been proved to be a useful supplement¹.

In an adult a mental age under 3 is generally accepted as the limit of idiocy. But the lower the intellectual level the more doubtful becomes the value of these tests.

Imbecility is assumed up to a mental age of 7. This group also frequently show physical and especially neurological symptoms. Speech is generally retarded and articulation is often poor. Emotional factors are most important in determining the patient's capacity for adjustment. Placid manageable docile types may be trained to some sort of work in spite of a low intellectual level whereas excitable restless types of higher intellectual resources may remain permanent inmates of mental hospitals. Sexual activity may be possible and female imbeciles often become prostitutes of the lowest class.

Both imbecility and idiocy are often combined with epilepsy i.e. the underlying brain condition gives rise to both mental deficiency and epileptic fits.

The diagnosis of a moron is more difficult not so much in the distinction from imbecility (which is mainly a matter of nomenclature) but in the distinction from normality especially normal stupidity. Once the idea has arisen it is not of course difficult to carry out suitable tests. But it is

¹ For details of the whole question see Burt C. Mental and Scholastic Tests London 1929. Terman L. M. and Merrill M. A. Measuring Intelligence London 1933.

surprising how rarely the physician thinks of this diagnosis if he sees the patient, not in a psychiatric out patient department, but in a general ward where he or she complains of peculiar sensations, or disturbs the other patients by behaving like a naughty or tiresome child. A considerable proportion of those who seem maddeningly incapable of giving a straightforward or consistent history are morons, and hypochondriacal reactions are very frequent amongst them.

Since the majority of morons live outside mental hospitals, this class is of much greater medical and social importance than the other two. The same variations of character are found among morons as in normal persons, but the intellectual defect, which is often coupled with poor powers of self restraint or "inhibition" often provides the background for certain anomalies of character, especially aggressiveness, criminal propensities, and sexual libertinism. The make up of the individual moron may influence even the test results by means of which the intellectual level has to be gauged. Lack of interest, and of concentration and effort, may bring the results below the "potential" intellectual level. Special disabilities, *e.g.*, in the field of speech, in reading, and in calculating, may have a similar effect.¹ Performance tests, used to supplement the Binet Simon scale or other "verbal" tests, may be of great assistance in examination. Earl has shown that the relation between the "verbal" and "performance" scores is of special significance, morons with psychopathic propensities tend to do better in verbal tests, while good results in suitable performance tests point to a good social adaptability.

Feeble minded persons contribute substantially to the number of criminals and prostitutes. Their fertility rate is higher than that of the average population, a point which has been largely used in the propaganda for sterilisation. It is however worth remembering that minor degrees of mental deficiency are fairly common in the lower social strata of the community, and that such persons are often useful members of the population not easily replaced in the performance of dull and simple tasks.

Ætiology and Pathology of Mental Defect—There is no single cause of mental deficiency, consequently no complete classification on ætiological grounds is as yet possible. Some types may be differentiated from an ætiological standpoint, but in a large proportion of cases no definite cause can be demonstrated. Hereditary mental defect may be distinguished

¹ "Idiot savants" are mental defectives who have exceptional abilities in a limited field, lightning calculators, memory prodigies etc., have been described.

from exogenous types, the latter may be due to germ cell damage, intra uterine disease, birth injury, or early cerebral disease. Though some types have certain characteristic clinical features, the differential diagnosis mainly rests on the physical findings.

The following types illustrate how far the problem of classification and pathology of mental defect is still from solution.

Microcephalic Idiots have very characteristic physical features. The skull is not only small in circumference 17 in or less, but it also has a characteristic shape. The forehead is low and receding, the occiput is flat and the chin poorly developed, thus making the profile unfortunate. Clinically, they are usually idiots but often at the upper level near imbecility. They are sometimes quite versatile can occupy themselves and may be trained to do simple work. They are generally well behaved and pleasant to other people and animals. There is some evidence that microcephaly is transmitted as a recessive gene, but intra uterine disease may play a part in its origin.

Amaurotic Idiocy is rare, but well known because of its peculiar clinical symptoms and characteristic post mortem findings (see p 814).

Hydrocephalic Idiocy (see p 765)

Mongolism is a very common condition. About 5 per cent of institutional cases of mental deficiency are mongols. Nothing is known about its ætiology. It is certainly not hereditary, but it is chiefly seen among last children of elderly mothers. Mongols have a characteristically flat face with oblique palpebral fissures which suggest the name of the condition. The nose is short and broad, the tongue large and often protruded. The skin is flabby the muscles hypotonic, the joints over flexible. There is often an umbilical hernia. Their low resistance against common infections accounts for their early deaths. The grade of mental defect varies. Mongols of all grades are generally of a friendly disposition, are easy to manage, and like play and music.

Tuberosc Sclerosis — This is a heredo familial disease. It is characterised by three groups of symptoms: nervous symptoms (mental defect and epilepsy), cutaneous symptoms (adenoma sebaceum, plaques of "peau de chagrin," café au lait spots), and fibromata (tumours of the retina, the heart, and the kidneys).

Mental deficiency is not present in all cases, where it exists its onset is always in the first two years of life the first manifestation being developmental delay in speech, gait, and habits. In a large proportion mental defect is very profound,

in some cases superimposed psychotic (catatonic) features make it appear even worse than it may be. All types of epileptic manifestations general convulsions Jacksonian fits and *petit mal* may be observed. Adenoma sebaceum consists of a nodular rash of yellow red or brownish colour which covers if fully developed a butterfly shaped area over the nose the naso labial folds (where it often begins) and part of the cheeks.

On account of the resemblance of some histological findings in the brain of tuberoscclerotic some authors are inclined to regard von Recklinghausen's disease as being very closely related the former is the cerebral the latter a peripheral manifestation of the same disease process. Mental defect is rarer in Recklinghausen families than in tuberoscclerotic.

Cretinism endemic as well as sporadic is often combined with mental deficiency the degree of which varies from mere dullness to the severest idiocy. The first definite symptoms mainly physical appear as a rule within the first two years of life. The mental development is retarded. The main features of the cretin's psychological state are lack of initiative slowness and clumsiness. Cretins are generally good natured and easily manageable. The physical appearance is very characteristic (see p. 270). The results of thyroid treatment on the mental state may be considerable if treatment is started early in life. The patients become more vivid though the intellectual state does not seem to improve.

ORGANIC SYNDROMES

Organic syndromes are distinguished by two main criteria (1) certain characteristic mental symptoms and (2) the aetiological preponderance of physical factors. These mental symptoms are known as organic mental symptoms and it is most important to be familiar with them for without this knowledge it is not possible to assess the importance of physical findings in mental disorder or to reach a conclusion as to whether they are coincidental or causal. Again their presence should lead to the search for relevant physical factors that might otherwise have been overlooked.

Classification of Organic Syndromes—It is convenient to make a necessarily rough division into those cases that are associated with permanent pathological changes in the brain and those which are not.

The former are known as organic dementias. By dementia is meant a deterioration of the personality predominantly in the intellectual sphere but also in the character. Impairment of

memory and judgment, emotional lability, and deterioration of the finer feelings are the predominant features

No single term has gained general acceptance to designate all the members of the second, or potentially recoverable class. These can be divided according to their severity into (1) organic neurasthenia, and (2) delirium and allied states

One syndrome may be present during the whole course of an organic psychosis, or the various types of reaction may alternate. All organic reaction types may lead to dementia but this may develop insidiously without passing through any of the other stages. Finally, delirious reactions frequently occur in the course of a progressive dementia

Organic Neurasthenia implies a state of fatigue and irritability often coupled with headache, hypochondriacal attitudes and subjective complaints of memory disturbance and difficulty in concentration

Mild cases never pass beyond such a condition, but the symptoms of organic neurasthenia are frequently seen both in the early stages and in the convalescence of the more severe reactions to be described below

A similar picture to that of organic neurasthenia is often however, seen, which does not result from the operation of organic causes (see Anxiety States, p. 1045)

DELIRIUM AND ALLIED STATES

These include (1) delirium (2) clouded consciousness and (3) Korsakow psychoses. There is a clear need for a dictator in psychiatric nomenclature for some of these conditions are also known as 'exogenous psychoses', 'infective exhaustion psychoses,' "toxic confusional psychoses," and "symptomatic psychoses" by different authors in different countries

Ætiology—Except in the case of the mental changes that follow the administration of certain rare drugs, such as mescal, the mental symptoms produced by various intoxications, or different forms of physical disorder and disease, are not in themselves specific. Thus typhoid fever and pneumonia can produce the same mental picture

The degree of mental disturbance, as well as its type, depends upon the constitution of the patient as well as upon the intensity and duration of the intoxication

Clinical Picture of Delirium—(a) *Physical Symptoms*—Apart from the accompaniments of the infection or intoxication in question a sluggish reaction of the pupils, nystagmus and diplopia are often found. Slurred speech and paraphasia are

not uncommon, and evidence of inco-ordination is brought out by attempted movements. Bladder control is often defective.

(b) *Mental Symptoms*—Important points are the following: (1) disorientation, (2) difficulty in grasp and impairment of memory, (3) increased suggestibility and responsiveness together with a tendency to embroider or to 'confabulate', (4) hallucinations especially visual hallucinations, (5) paranoid features and (6) restlessness or psychomotor activities variously elaborated. The lucidity of consciousness changes quickly: a patient may be deeply somnolent when left to himself but give a few quick relevant answers when roused.

Variability in all the symptoms, which is constant unless the patient is so toxic as to be stuporous, is clearly bound up with the increased responsiveness, for these patients respond to all stimuli with abnormal facility and intensity. The increased suggestibility, with which is coupled the tendency to embroider or to elaborate, can often be shown when patients can be induced to read from blank sheets of paper, or when these patients give a circumstantial account, which is entirely untrue of where they have been or what they have done. The same point is shown in the various misinterpretations. Every type of experience is liable to be misinterpreted. Thus the bed cover may be thought to be a coat, the doctor is mistaken for a relative, or a sore tongue is attributed to malicious burning. These misinterpretations are in part dependent upon expectations and fears and they frequently, as in the last instance, display paranoid tendencies. They are also dependent upon the difficulty in grasp and clonding of consciousness which in some degree, is invariable. This constantly changes but at all times attention is poorly sustained, concentration is difficult and thought is laboured and often disconnected. These patients readily tire, are distracted by outside happenings, or sink back into the confusion from which they have been partially aroused. The memory for recent events is particularly poor, and in the more severe cases gross disorientation is shown.

Visual hallucinations are extremely common and are highly characteristic (see p. 986). They can be terrifying and are most frequent in acute intoxications. Auditory hallucinations are less frequent, but may persist for a time after visual hallucinations and evidence of gross confusion have disappeared. A smaller number of patients complain of olfactory and tactile hallucinations. The hallucinations have frequently an illu-sional basis.

All the points that have been mentioned are clearly seen in the paranoid attitudes and delusional ideas which are

typically transient and ill systematised, and which are, in part at least, dependent upon the difficulty in grasp, for if difficulty is experienced in a clear grasp of what is taking place, it is comprehensible that doubt and suspicion should arise. Further, they are in part dependent upon the increased suggestibility. Misinterpretations are often the starting point for delusional formations.

All delirious patients at some time and to some extent feel themselves the subjects of persecution or annoyance, which may range from vague ideas of reference to more crystallised beliefs evidenced by talk of plots, gangs, wars, and revolutions. Others believe they are to be poisoned or killed or tortured, or that they are in danger and about to be robbed or kidnapped.

The degree of restlessness varies, and ranges from tremor to the most highly co-ordinated and purposive movements. Many toss and turn, grope, kick, and rub. "Investigating" and occupational activities are highly characteristic. These patients will search vaguely or indulge in activities familiar to them, such as driving their cars or telling their rosaries. Finally, as might be expected, the mood is commonly a dreamy, dazed drifting state, very labile, and with rapid changes. Perplexity, irritability, mistrust, and definite suspicion are frequently seen. Anxiety may change into frank fear, and in many fear is the dominant affect throughout. Talk of suicide, or even definite suicidal attempts are by no means uncommon. On the other hand, euphoric states and phases may be seen.

Delirium Tremens is the term commonly applied to acute delirious reactions of alcoholic origin. They usually last between three and six days, and end suddenly, often with a long sleep. Though it is quite true that alcohol is the most common cause of acute delirious reactions with confusion, restlessness, fear and vivid visual hallucinations as prominent features, yet the same picture may result from other intoxications. It is not therefore necessary to describe the symptoms of *delirium tremens* separately. The physical symptoms, namely, tremor, ataxia, tenderness of the nerve trunks, may lead to the correct diagnosis.

The dominant features of the delirious reaction can be summarised by the statement that it is a variable, restless, suggestible, confused and clouded state with a striking frequency of visual hallucinations and paranoid tendencies and ideas accompanied by a labile mood predominantly irritable, anxious, fearful, and depressed. Such a general statement leaves out the individual personal setting and colouring which plays a large part in shaping the delirious reaction that is

shown. This connection is more obvious if the disturbances are of relatively light intensity, for if the depth of the disturbance is too great, individual differences tend to become blurred. In the less severe disturbances manic or depressive features, or whatever it may be, may greatly colour and even appear to dominate the picture.

Prognosis—The prognosis of a delirious state will of course necessarily depend mainly upon the physical disorder or disease responsible for the condition. Physical prostration consequent upon restlessness and excitement may, however, materially alter this course, and may induce a fatal issue which otherwise would not have taken place. Broadly speaking, the unstable and psychopathic, the young and the mentally defective are particularly liable to develop delirious reactions of a wild and impulsive type.

In the vast majority of cases the prognosis as regards the mental state is excellent, and recovery is rapid and complete. There are, however, certain important exceptions. It is not uncommon to see delirious reactions resulting from alcohol or bromide superimposed upon other psychoses, and after the delirium has cleared up the underlying psychosis will then become evident and rapid recovery will not take place. A careful history should avoid this difficulty.

Again, delirious reactions may usher in a psychosis of an ominous variety which was not apparent prior to its onset. Certain schizophrenic and paranoid psychoses may start in this way.

It is always wise to be more guarded about the prognosis if the personality of the individual sufferer is such as to give grounds in general for psychiatric concern, especially when schizophrenic features are to be observed during the course of the illness itself.

Finally, a delirium occurring in those with organic brain disease may clear up, leaving an organic dementia of greater or less degree. Korsakow syndrome is a frequent sequel of alcoholic delirium.

Treatment—Attention to the underlying physical cause of the condition is of course the first consideration, but a great deal can be done in other ways.

It must be remembered that these patients are unable to differentiate or discriminate, or to grasp situations that are new, complex, and unfamiliar. Thus, particularly in the case of elderly patients, removal to the strange atmosphere of a hospital ward may precipitate mental symptoms.

Conversely, quiet, simple, and familiar surroundings tend

to prevent or ameliorate delirium, and it is most important to try to reduce the chances of misinterpretation to a minimum. Constant reassurance and explanation must be given, preferably by the same doctor or nurse, for these patients can be soothed and quietened nearly as readily as they can be upset and perplexed.

Simple Clouding of Consciousness—In many cases a fully developed delirious reaction never occurs. During the day such patients may complain merely of feeling weak and tired with difficulty in concentration and examination may only disclose some mental dulling or slowness. During the night however, and in the more severe cases during the day as well definite confusion with transient disorientation and difficulty in grasp may become more obvious. With this are frequently coupled visual hallucinations, at first hypnogogic, or of the "elementary" or simple type that has been described (see p. 980). In addition, there may at times be evidence in various forms of the labile mood change described in classical delirium, as well as fleeting paranoid tendencies or ideas of reference. Restlessness and broken sleep may also be observed.

Bromide Intoxication—These states of simple confusion are not uncommon in the less severe degrees of bromide intoxication and when this is so, the diagnosis is frequently missed because of the predominance of the depressive or anxiety symptoms for which bromide has been ordered.

An apparent change for the worse in any 'functional' syndrome taking the form of increased suspiciousness nocturnal restlessness, and especially increased difficulty in grasp, should always raise the possibility of bromide intoxication, and when tests for intellectual capacity (memory, calculations, etc.) reveal defects, these suspicions should be strengthened. The examination of the blood bromide will then clinch the matter.

Korsakow or Amnesic Syndromes—In this variety of organic reactions which, it is important to stress, although most frequently to be observed in, is not confined to alcoholism, the memory disturbance is the most striking feature, and not the difficulty in grasp or clouding of consciousness. On the contrary, these patients may at first sight appear to be normally quick in the uptake, and they often speak with great fluency and apparent plausibility. But examination reveals gross memory defects. These defects are most obvious in the appreciation of time relationships, especially for recent events. In order to compensate, as it were, for these memory defects, these patients *confabulate*, and often show the most striking suggestibility, so that they tell the most extraordinary and inaccurate tales,

amplifying them with full and quite fictitious details on little pressure. A lack of initiative and a fatuous or indolent mood are commonly seen. Polyneuritis originally described as an essential feature (polyneuritic psychosis) may or may not be present.

A large proportion of the cases of amnesic syndromes develop out of a delirious state.

The prognosis of a fully developed Korsakow syndrome is poor and the usual outcome is a silly cheerful but irritable condition with some disturbance of initiative and grasp.

THE ORGANIC DEMENTIAS

All organic dementias have many features in common and the main characteristics have already been given. They resemble the potentially recoverable organic syndromes in that the clinical pictures also seem to be mainly referable to the intensity of action and duration of operation of the morbid process and to be at least relatively independent of the exact nature of this process.

The possible variations in the clinical picture and course will best be appreciated by considering them under some of the more common causes responsible for their production. It must be appreciated that the various morbid processes to be described though they tend to produce permanent pathological changes in the brain do not always do so with the result that the degree and type of dementia and the possibilities of partial or complete recovery or remission vary.

GENERAL PARALYSIS OF THE INSANE

In this section only the mental symptoms are dealt with. Other features of the disease including the results of medical treatment are dealt with elsewhere (*vide* p 853 and p 86). The cardinal symptom is a progressive deterioration of the personality both in intelligence and in character. Depression, excitement, stupor and disturbances of consciousness can be regarded as accessory symptoms which may or may not be present. The onset is usually gradual and even when the disease appears to start suddenly or dramatically with a state of confusion or fit a careful history will generally reveal the presence of symptoms of an organic neurasthenia previously. These include headache, fatigability, slight complaints or evidence of memory failure and reduced resistance to alcohol. Some change in behaviour

may have been observed by relations or friends who knew the patient intimately. Thus it is common to hear that patients have been more irritable, more egotistic and less considerate than formerly, that they ate, talked, and drank more than was their previous wont, and showed less sexual restraint. Objective evidences of memory impairment, especially for recent events, names, and dates, may have been evident, and the patients may have become more careless and their writing less tidy and correct. In spite of these early symptoms, the patients may be able to deal with their work well enough, especially if it is of a simple or routine nature. But they often fail when called upon to show any special initiative or judgment, or when faced with any exceptional or difficult task. This may lead to the belief that the stress imposed by the particular situation has led to the breakdown, which is thought to be of a so called functional type, and hence diagnostic mistakes may be made unless a careful history is taken and a thorough examination carried out for organic signs.

With the progress of the illness the patient becomes more indolent and apathetic. Depression, when it occurs is superficial. Hypochondriacal and melancholic ideas are often silly and inconsistent. Disturbances of memory are prominent features, and even when immediate retention (see p 983) is not so bad, recollection and reproduction of recent material is often grossly at fault. This is apparently due to the combined effects of disturbances of attention, of the capacity to synthesise, and of remembering in the more strict sense and other factors that contribute are the disturbances of judgment that interfere with the patient's capacity to criticise and correct his own wrong answers, especially when this is combined with a lack of interest.

The final stage of the illness is characterised by a profound and generalised dementia. The defects of memory grow, until even old and familiar material, such as the dates of birthday, and of marriage, and even the names of children, disappear. The patient fabricates spontaneously, or can be induced to do so. The disturbance of memory and judgment finally becomes most profound. One patient threw his cigar butt out of an upper window, and wanted to follow it through the window to have another puff, and another patient, with optic atrophy, constantly forgot his blindness and asked for the lights to be turned on.

The most contradictory statements can be made and accepted. The mood varies between apathy and euphoria, and the characteristic emotional lability is generally evident. Hand

in hand with the mental deterioration goes a progressive physical deterioration leading finally to an extreme degree of wasting and paralysis

The course of the disease and the clinical picture may differ considerably from that which has been described. There is an acute type, rapidly progressive, often with numerous fits and a very bad prognosis. The expansive or classical form which is nowadays rare, is characterised by a demented euphoria and ideas or delusions of grandeur ("Ho, he, he," said one patient when asked to multiply five by two, "you can't catch me ten million")

Depressive symptoms in the depressive form may disguise the dementia, although the melancholic or hypochondriac ideas usually lack coherence and system. Catatonic and paranoid pictures may occur in the course of the illness, the latter with relative frequency during or immediately after malarial treatment

Juvenile paralysis develops as the result of congenita instead of acquired syphilis. There is a progressive intellectual deterioration with the usual neurological accompaniments. The picture is even less dramatic than the simple demented form of the adult type, and the prognosis is bad

MENTAL SYMPTOMS WITH VASCULAR DISEASE

The mental symptoms that occur with hypertension whatever its pathology may be, can be distinguished from those that result from arteriosclerosis, though possible transitions and variations must be borne in mind

The presence of either hypertension or arteriosclerosis often facilitates the production of other types of reaction of so called functional type, thus the presence of the symptoms of anxiety or depression may, and not infrequently do so dominate the picture that organic factors and organic mental symptoms may be overlooked. Similarly hysterical reactions are often 'released'

The preliminary stage of either type of cerebral vascular disease shows the non specific but characteristic picture of organic neurasthenia—increased irritability and fatigability, headache, insomnia, subjective disturbances of memory, and frequently giddiness. The irritability is often associated with a tendency to become easily "flustered" (organic lability of mood)

Hypertension—Short attacks of interruption of consciousness, very similar to petit mal, may occur. What might be

regarded as an extension of the same phenomenon, namely, confusional states of variable duration and with varying features, may also call for psychiatric treatment. Such attacks may follow an apoplectic seizure, but in other cases no neurological signs can be discovered on which the assumption of structural damage to the brain can be based. During these confusional psychoses, the blood pressure may be either higher or more fluctuating than it was before.

The clinical picture may be that of delirium, and, especially when the patient is an alcoholic subject, an acute delirium. In other cases, depressive or, more rarely, manic pictures with confusional features dominate the picture, and finally ecstatic states can be observed.

Prognosis—The normal duration of these attacks is a few weeks to a few months, but in some cases the psychosis only lasts a few days.

The confusions that so frequently occur at night in arterio-sclerotic and senile patients may well be of the same nature.

The prognosis for these states in themselves is good, but there is always the danger that the emotional disturbance, and concomitant rise in blood pressure, may precipitate a cerebral hæmorrhage.

Recovery, when it takes place, is usually complete, but repeated attacks usually leave behind residual symptoms, often at first very slight. In the long run, essential hypertension, with or without acute episodes, and with or without apoplectic strokes and subsequent focal symptoms, is liable to bring about an alteration of personality. These patients become irritable, difficult to get on with, forgetful, narrow in their outlook, labile in their emotions, and less dependable in every respect. Their intelligence is, however, very slightly impaired, and they usually retain very good insight. This, coupled with their emotional lability, tends to increased self observation and worry about their condition, with secondary bad results on the blood pressure.

Treatment—This vicious circle should be the object of psychiatric treatment, and even the hypertension itself may respond well to suitable psychological management and psychotherapy.

Arteriosclerosis—In arteriosclerotics the neurasthenic syndrome of the prodromal stage blends into that of a slowly progressive dementia. Arteriosclerotic deterioration differs from the intellectual deterioration produced by other causes, especially general paralysis of the insane, in that arteriosclerotic deterioration is more patchy and less generalised. The façade

of the patient's personality is preserved longer and more completely. For a considerable time what might be called the peripheral functions of intelligence are impaired rather than the "central" functions of judgment, reasoning, and insight.

Thus the patient may show marked impairment when examined by the usual tests for memory, but be able to keep his end up and to conceal his defect from the outer world with the aid of a note book or diary and a strict routine though he may have to struggle very hard.

The disturbance of the finer feelings that is so conspicuous in early general paralysis of the insane is absent in the early stage of arteriosclerosis, but as the illness progresses it becomes more apparent. The patients develop, together with an increased emotional lability, a gradual deterioration of their higher feelings and social instincts. They become increasingly egotistic, and feel less warmly about their friends and relations. Sexual activity may reappear as the result of impaired inhibition and owing to the lack of opportunity or capacity for normal satisfaction, the patient may finally fall back on infantile forms of gratification, such as exposure and obscene practices with children. These patients are often referred to the psychiatrist by the courts.

Insomnia is a characteristic symptom of the early stages and may finally lead to, or be combined with, the motor restlessness and slight confusion that develops as the disease advances. The patients become exhausted by their nocturnal restlessness and sleep half the day. They may damage themselves during these periods of restless confusion at night either by falling when they try to get out of bed, or by stumbling in their disorientated state in the darkened room.

The picture is often complicated by focal symptoms due to cerebral thrombosis.

The Differential Diagnosis from early general paralysis of the insane and cerebrovascular syphilis is the main problem. Though the types of dementia show some characteristic differences already described serological examinations of the blood and cerebro-spinal fluid must be performed. A slow growing cerebral tumour may produce a similar mental picture.

Prognosis—The ultimate prognosis in cerebral arteriosclerosis is bad, but it is difficult to predict the rate of deterioration.

Treatment—The treatment is that of arteriosclerosis in general (see p. 572). The psychiatric therapy is purely symptomatic.

SENILE DEMENTIA

Senile dementia may be looked upon as an exaggeration of the usual psychological changes of old age. It is a progressive deterioration in which disturbances of memory are conspicuous. It is normal for people in their old age to become more narrow in their outlook and rigid in their views. Senile patients show these points in exaggerated form or even in caricature. In addition, they have difficulty in grasp. The combination of these factors leads to increased distrust and suspicion, and provides the basis for the numerous paranoid features of the senile. The disturbances of memory and of judgment prevent these ideas from being developed into a real delusional system, but ideas of reference and of persecution are very common. The senile patient often complains that everything is stolen from him, and such ideas are favoured by greediness and forgetfulness.

The patients become increasingly egotistic and their emotional life becomes shallow, the deaths of near relatives make little impression. In contrast to the emotional poverty, emotional expression may be increased (organic lability). Decrease of potency and loss of control account for sexual offences, such as lewd practices with little girls. A person committing such an offence for the first time in old age should always be examined by a psychiatrist. Senile dementia is often not recognised in its earliest stages by the layman.

The interest and initiative shown by the senile decrease often rapidly, but sometimes they develop an empty restlessness, especially in the evening and at night. They then totter about aimlessly, more or less confused, start to get up, to pack, or try to leave the room or house.

Presbyophrenia—This is generally described as a particular type of senile dementia, and is characterised by a very gross memory impairment for recent events, coupled with an unusually well preserved personality. These patients are generally pyknic in build and possessors of a hypomanic temperament.

The physical symptoms are those of old age. Tremor, an impassive expression, and an increase in muscle tone are often seen. Gross focal symptoms are evidence of superimposed vascular disease and do not belong to the typical picture.

The Morbid Anatomy of senile dementia shows histological changes apart from the general signs of senile involution of the brain that are not, however, entirely specific. They need not be gone into here.

The Prognosis for senile dementia is, naturally, very bad as regards recovery, the prognosis as regards life depends upon the physical state of the patient. Much restlessness and confusion tend to shorten the course owing to physical complications.

Presenile Dementias—Whereas the usual age for hypertensive disease is between forty five and fifty five, for arterio sclerosis between fifty five and seventy, senile dementia rarely begins before the seventieth year of life. But there is a group of cases where a slowly progressive dementia, similar to senile dementia, is observed earlier in life, beginning in the fifties. Amongst others the following types have been described—

1 *Alzheimer's Disease*—There are certain features that make the diagnosis of Alzheimer's disease possible, even apart from the age of onset. The dementia is very profound, but the behaviour of the patient and the emotional responses are surprisingly well preserved. Symptoms of aphasia, agnosia, etc., are also frequent, but less well defined than when they result from focal lesions of vascular origin. Stereotyped movements and speech are very common, the latter finally deteriorating into repetitive utterances that are meaningless.

2 *Pick's Disease* is somewhat similar in its clinical picture but differs in pathology. Circumscribed areas of atrophy can be found in the frontal or temporal lobes, or both. This disease is sometimes familial.

The clinical picture in the early stage often resembles that of general paralysis of the insane. Death occurs after six to twelve years.

3 *Huntington's Chorea* is often given as a third type of presenile dementia (see p 813). The dementia has no particular features, changes in character sometimes precede impairment of memory and judgment, and both may be evident before the chorea develops.

MENTAL SYMPTOMS IN ENCEPHALITIS LETHARGICA

The mental symptoms during the acute phase show nothing exceptional or particularly characteristic. After recovery from this phase the patients are often inert, restless, and slow, and the development of Parkinsonism is generally preceded by a neurasthenic picture, the patients being described as irritable, moody, and hypochondriacal. The Parkinsonian state is generally accompanied by a slowing down of all psychic processes and is not associated with a true dementia. But this general slowing is combined with loss of initiative which may give rise to a picture that resembles a dementia, and which

certainly results in the reduction of the level of the previous personality, yet tests demonstrate that all the fundamental mental faculties are well preserved. Sometimes schizophrenic or paranoid pictures develop, and the obsessional and compulsive phenomena that occur during the oculogyric crises are of great theoretical interest. The patients report that during these crises they feel impelled to say or to do something. They may also show obsessional symptoms between the attacks.

Encephalitis lethargica occurring in childhood may result in a peculiar picture, and produce a very gross change in personality. After the acute phase, children may become increasingly restless, irritable, and aggressive, and appear to lose all moral sense. They beg eternal life, and are cruel to other children and to animals. They talk incessantly, cling to those they meet and cannot be detached, and become unmanageable at school and at home. Abnormal sexual curiosity and sexual problems are also often observed. Even in milder cases lack of concentration interferes with any successful work at school or subsequently.

Post encephalitic adolescents sometimes show certain features of the above syndrome especially a lack of sexual restraint.

The prognosis of post encephalitic conditions in children was originally regarded as very bad but follow up studies show that about one third become socially adaptable in spite of organic brain disease, another third develop Parkinsonism.

MENTAL SYMPTOMS IN EPILEPSY

Epileptics are often subject to periodic changes of mood, characterised by suriness and irritability. Such periods may or may not precede epileptic attacks.

Epileptic psychoses usually follow an epileptic attack, but they may also occur independently. In the first instance, the patients do not recover consciousness as usual, but remain in a clouded state, disorientated, confused, slow in grasp and tending to perseverate. They often appear tense and perplexed, and are sometimes restless. They may wander about and are often arrested by the police because they are behaving in a strange manner. It is this type of patient who may be seen suddenly undressing in the street or exposing himself. In other cases this picture of simple dimming of consciousness is complicated by hallucinations and motor excitement giving rise to the picture of an epileptic twilight state. The hallucinations are unusually vivid and great fear is a very prominent

feature. Sometimes a religious ecstatic mood and a corresponding content prevail.

Epileptics in twilight states are the most dangerous patients. They defend themselves against their supposed attackers, or attack those about them. They refuse any sort of treatment, struggle wildly, and may attempt suicide. Patients with recurring twilight states always seem to act in a very similar way. These twilight states seldom last longer than a fortnight, and no means of cutting them short is known. Close supervision is necessary, and treatment by some form of continuous narcosis is often adopted. Some patients respond to luminal by the development of these twilight states and this should be borne in mind when deciding on treatment.

At least two thirds of all epileptics show progressive deterioration of variable degree, and there is some correlation between this deterioration and the number of fits. The psychological picture of epileptic deterioration can be regarded as an attenuated form of the post paroxysmal confusional reaction. Patients become slow, have fewer ideas and associations, and tend to express themselves in an increasingly circumstantial manner. Their mental horizon narrows, and they lose interest in all except themselves and their illness. "My fits" become their favourite topic, and there is often an interesting contrast between this increased concern and their optimistic attitude towards their disease. They tend to believe that their fits have now ceased or their number is decreasing or their severity is less. This makes it difficult to judge the result of treatment without observation in hospital. Epileptics are often outwardly submissive and polite in their peculiar circumstantial way. Many of them turn to religion and become over-devout and bigoted, but it is the devoutness of religiosity, and fundamentally they are sensitive, irritable, suspicious, and egotistic. If there are several epileptics in the same ward they usually quarrel. The epileptic disturbance of memory is mainly, especially in the early stages, a difficulty of recollection, another expression of their poverty of association. It is therefore noticeable both for remote and for recent material.

MENTAL SYMPTOMS FOLLOWING HEAD INJURY

Concussion is characterised by loss or impairment of consciousness which may vary from simple dimming of short duration, to complete unconsciousness lasting for hours or days. During recovery from the latter the patient

passes through the stages of dimming of consciousness as described on p 977 Subsequent amnesia and retrograde amnesia are discussed on p 984 Neurasthenic symptoms especially headaches (of an organic character) may exist for a considerable length of time after a concussion

In severe concussion and cerebral contusion recovery from unconsciousness is protracted and various complications may arise The patients may remain slow in grasp with little initiative and with more or less severe disturbances of remembering with or without the tendency for confabulation or they may become restless excitable and actively delirious They are often extremely cheerful and have surprisingly little insight into their condition even after the acute phase of delirium has passed The recovery is gradual a state of depersonalisation may be observed in the transitional stage

A confusional state may sometimes be observed as the result of cerebral compression occurring instead of unconsciousness but possessing the same *diagnostic significance*

The prognosis for post traumatic psychoses depends on the type degree and extent of the brain injury and on the general physical condition of the patient Arteriosclerotic and alcoholic patients are less likely to recover as quickly and as completely as do young and vigorous patients Severe post traumatic psychoses not uncommonly last as long as three months and in a proportion of cases the recovery from delirium or an amnesic syndrome is followed by a neurasthenic condition

Focal symptoms sometimes point to localised damage to the brain and poverty of motor activity with euphoria and lack of insight may be signs of local injury to the frontal lobe The lack of insight is often not recognised as a morbid symptom at all

When symptoms persist after damage to the brain they have the general characteristics of dementia in which sometimes intellectual impairment and sometimes a change of character predominate Traumatic epilepsy may in severe cases lead to a *progressive epileptic dementia*

In a small number of cases psychoses of manic depressive or more frequently of schizophrenic type follow head injuries the more closely they are related to the accident the better the prognosis

Differential Diagnosis—After head injuries as after other accidents mental symptoms may develop that are not due to the injury to the brain but to the emotional shock and to the subsequent distress consequent upon the physical injury or altered circumstances arising indirectly from the accident

The so-called shock neuroses are rare after serious head injuries, probably owing to the subsequent amnesia for the accident itself. Far more common are hysterical reactions (see p 1047). But when examining a post-concussional case with neurotic symptoms it should be borne in mind that the type of response shown by a patient can be altered by damage to his brain, all patients, and especially those who give no history of previous hysterical symptoms or hysterical predisposition, should therefore be examined most carefully for organic mental symptoms, organic lability of affect and disturbances of concentration and memory will often be disclosed by a thorough examination or from a careful history obtained from an independent source.

SCHIZOPHRENIA

(*Dementia Præcox*)

The term schizophrenia ("split mind"), first proposed by Bleuler to describe what he held to be the cardinal feature, is now substituted for the older term *dementia præcox*, which gives an unfortunate and misleading impression, for there is complete agreement that the onset in these psychoses need not necessarily be early (*præcox*) nor result in a dementia.

It is now believed that "paranoid states" or "systematised delusional insanities," which are sometimes described separately, should really be regarded as belonging to the schizophrenic group, which is hence sometimes described as the "schizophrenic paranoid series."

The discussion on the definition and delimitation of the schizophrenias is not yet closed. Difficulties arise because some writers use the term schizophrenia as the name of a disease (characterised by certain cardinal symptoms its course and a hypothetical pathological 'process'). Here it is applied to a clinical syndrome independent of cause, course and possible pathology. Confusion may be avoided if a distinction is made between schizophrenic symptoms and a series of schizophrenic illnesses.

Clinical Picture—The clinical symptoms in the different types of schizophrenia are so numerous and varied that it is proposed to describe them first, and to deal later with their relative diagnostic values and their grouping in different syndromes and types.

Emotional Disturbances—Irritability and oversensitiveness may be early symptoms, but shallowness or poverty of emotional

response, together with a general apathy and loss of interest in the outside world, are more characteristic. Loss of emotional rapport may often be felt by the observer or by the friends and relations before it becomes clearly manifest in the patient's behaviour. Yet the patient may feel it himself and complain of it, or he may experience it as a change in the outside world. In more advanced cases the loss of emotional response is often disguised behind a silly cheerful indifference. Schizophrenic incongruity and inadequacy of affect (see p 982) are often clearly seen in these more advanced cases, and thus may make the patient's emotional response appear incomprehensible to others. Finally, the indifference and emotional impoverishment play an important part in leading to dirtiness, self neglect, self-exposure, and shameless masturbation.

Disturbances of *emotional expression* are closely related to, and are often difficult to distinguish from, inadequate and incongruous emotions. Giggling for no apparent reason, or for an apparently inadequate reason, is often an early anomaly, and in later stages, quite apart from its appropriateness, the expression of emotion may be unusual in itself, stiff, or slow and bizarre, so that the patient's behaviour resembles had acting.

The emotional deterioration leads to a progressive withdrawal of these patients from contact with the outer world, so that they become more and more solitary, self absorbed, and frequently hypochondriacal, until finally they appear to live entirely in a world of their own.

Disturbances of Volition are often combined with the emotional disturbances. The patient may himself complain of lack of energy before the friends and relatives notice the poverty of initiative, and the lack of decision and determination. In the later stages, these may become so profound as to leave the patient an *immobile figure* sitting or standing about in the wards of a mental hospital. But when the disturbance is less severe, patients of this type are frequently found either sitting about at home, or amongst the vagabonds who drift about the world without aim or purpose.

The severest form of this disturbance constitutes stupor, which may be combined with abnormal suggestibility shown in its extreme degree in the so called automatic obedience (see p 979).

Ambivalence is the term used for another characteristic schizophrenic feature. *contradictory impulses* are present simultaneously, or arise in rapid succession. This is often well seen when such patients are asked to shake hands. Thus the

patient may begin to hold out his hand and then withdraw it, the examiner then withdraws his hand, whereupon the patient holds his hand out again, only to withdraw it once more when the examiner makes a response. When a request or suggestion is immediately followed by counter impulses the disturbance is called *negativism*.

Disturbances of Motor Activity—The same incongruity may be observed in the various types of schizophrenic activity. A state of apathy may be interrupted by the performance of some sudden impulsive action, so that these patients may suddenly start shouting for no apparent reason, become destructive, or attack others. These sudden outbursts of activity are sometimes carried out in obedience to hallucinatory voices, but in other instances patients who are able and willing to provide information are often unable to give any reason for them.

States of more prolonged excitement are also common, the patients may indulge in strange attitudes, or show peculiar movements apparently expressive of such states as terror or ecstasy, or they perform wild and purposeless, apparently incomprehensible, movements. The movements themselves are often not performed with the normal degree of precision and co-ordination. Stereotyped repetitions are often seen, such as rocking, knocking and rubbing. These anomalies of motor activity are often included in a group of symptoms that are called *catatonic* (automatic obedience, echo actions, stereotypy).

If *flexibilitas cerea* is combined with automatic obedience, the picture of *cataplexy* results (see p. 976).

In mild cases, a lack of gracefulness may be an early sign, and in more advanced cases the movements may become peculiarly stiff and clumsy and finally result, owing to the addition of tic like movements and distortions and alterations of the normal tempo, in the so called *mannerisms* which make the whole behaviour appear very eccentric and bizarre. Slight *mannerisms* may be left as a residual symptom after recovery.

Some patients are very well aware of their disturbance of volition, but in many instances it is projected and rationalised, so that the patients come to believe that others interfere with their decisions and actions and that their will is under some outside control (*passivity feelings*). The primary disturbances of volition may be variously elaborated and systematised into delusional ideas according to the strength of the paranoid tendencies. Many *catatonic* phenomena are explained by patients as due to the actions of voices.

Thought Disorder—A poverty of ideas and associations

may be all that is noticeable at first, but a sense of sudden interruption or blocking in the stream of thought is more characteristic

The most important characteristic of schizophrenic thought disorder is seen in the type of the associations. In well advanced cases this becomes evident in the spontaneous utterances which sound incoherent or entirely incomprehensible but in milder cases it may only come to light if the patient is given a set problem, or as the result of association tests

The thought disorder cannot be reduced to a single mechanism, but some of the components such as condensation and displacement of ideas, as well as a tendency to symbolic thinking, may be discerned. These all resemble dream mechanisms. Hence schizophrenic thinking has been compared with the type of thinking which many normal people experience immediately before they go off to sleep, or when asleep

The schizophrenic thought disturbance may result in "double orientation." Thus, a patient may believe he is God or the King, and may act and speak accordingly. But at the same time he may act and speak as an inmate of a mental hospital and will argue with the doctor and complain about the other patients

These two lines of thought may be kept up in spite of all contradiction, or they may be interwoven. There is no logic, or the logic is peculiar

From the subjective point of view schizophrenic patients may, in the early stages, complain of difficulty in concentration. Many such patients turn their attention to subjects that lend themselves to vague speculations such as mysticism and spiritualism, and so called philosophy and psychology, and this is often interpreted as an over compensation for their vaguely felt incapacity. But when the thought disorder becomes worse, the patients usually lose insight gradually. The thought disorder colours the various delusional systems, and is one of the main constituents of the so called schizophrenic dementia

The elements of language may be well preserved, but various mutilations of individual words may occur, so that the verbal production of these patients may resemble that of an aphasic. In the most severe stages, language is disintegrated into a sequence of incomprehensible syllables and neologisms (word salad)

Early cases often show an inclination for highbrow, odd or

artificial expressions (mannerisms of speech) and the newly coined words or neologisms that appear later usually result from the patient's urge to describe his experiences, for which purpose an ordinary vocabulary is inadequate

Hallucinations of any of the senses may be found, but auditory hallucinations are the most frequent and characteristic (see p 986) Their clarity varies Some patients are able to describe the character of the voices in great detail and the impression may be so vivid that the patient answers hallucinatory questions and discusses the statements of his supposed interlocutors Other patients, although they are immediately aware of what the voices say, cannot repeat the exact words or otherwise describe the sensory character of their experience The voices are generally disagreeable, threatening, aggressive, and abusive, and frequently make allusions to sexual matters Sometimes the voices give orders that are often carried out to the letter, and hence it is always important to determine what hallucinatory orders are received

The most characteristic type of schizophrenic hallucination occurs when the patient hears his own thoughts repeated either immediately before he has conceived them, or simultaneously with the process of thinking, or immediately afterwards In later stages the voices become more incoherent and incomprehensible, and neologisms often appear

Visual hallucinations are rare (see p 986) Sometimes patients complain that small pictures flash through their visual field, or that the objects they see look distorted, or that the vividness or quality of what they see has changed

Hallucinations of taste and smell are often woven into the delusional ideas, in the production of which tactile or other physical sensations also play an important part

Hypochondriacal self concern is a very important and frequent aspect of the patient's introversion Paresthesiæ and various pains may be described in detail, and the peculiar sensations are often described at first with the help of strange metaphors thus, feelings as if the body were twisted or as if the testes were galvanised But soon the descriptions lose their "as if" character, and the patients then say that their bodies are twisted and that they are galvanised These hallucinations gradually blend into hypochondriacal delusions which typically have a very bizarre character

Schizophrenics very commonly complain of feeling influenced by rays, or complicated physical devices, or of being the victims of all kinds of lewd practices

The hallucinations lead to all manner of explanatory

delusions, but the characteristic schizophrenic delusions are known as "autochthonous" delusional ideas (see p 981). These "primary delusions" are elaborated, explanations added, and the whole starting point of the delusional system may be subsequently forgotten. The degree of systematisation and elaboration of the schizophrenic delusions depend to a large extent on the severity of the coexisting thought disorder. Ideas of reference and delusions of persecution are the ones most commonly found, in addition to hypochondriacal delusions. Thus, patients come to believe that others are against them, that their relatives, the police or the Jews persecute them, until finally everybody is involved in the plot. The passivity feelings (see p 979) are usually given a paranoid twist, and all the delusional ideas are often confirmed by the hallucinatory experiences. Delusions of grandeur may co exist with the paranoid delusions, but they may also exist independently. Thus, the patients often believe they are persecuted because they are the possessors of remarkable powers, or because they are the Messiah. Erotic aspirations towards those of superior social status are frequently seen.

Misinterpretations of the most varied kinds, such as of the pictures or advertisements seen in the newspapers are often quoted to confirm the delusional system.

Although for practical purposes it is much more important to distinguish the clinical types the following entirely schematic classification may be useful in remembering the main symptoms.

- 1 Symptoms of Withdrawal. Introversion, hypochondriasis—emotional and habit deterioration—stupor
- 2 Symptoms of Splitting. Double orientation—ambivalence—thought disturbances and incongruity of affect—impulsive actions
- 3 Paranoid Symptoms. Projection—hallucinations—delusions

Clinical Types of Schizophrenia.—Three groups are commonly recognised (1) Simple—hebephrenic, (2) Catatonic, (3) Paranoid—paraphrenic.

1 *Dementia Simplex*—*Hebephrenic Group*—Dramatic symptoms are characteristically absent in the early stages of this type, which usually begins in late puberty. The patient shows a falling off of interest and initiative, and the decreasing capacity for adaptation to ordinary life may be disguised in hypochondriacal complaints. Sometimes the hebephrenic process seems to stop at this stage, leaving behind an odd, dry,

withdrawn, egocentric hypochondriacal personality as a defect. In other cases the patients show an increasingly poor work record, tend to neglect themselves in their personal appearance and friction arises with other members of the family for no apparent reason. The patients lose their self criticism and self control, and become very exacting or even brutal. This behaviour may be difficult to distinguish from the cURLishness of adolescence, but usually occurs beyond the age when a reaction of puberty would be a justifiable explanation. With the progress of the illness the withdrawal from reality becomes more marked, the hypochondriasis increases and becomes more bizarre, evidence of thought disorder becomes noticeable, the emotional response becomes more shallow, slightly paranoid ideas and finally hallucinations may develop. These symptoms are often masked by a fatuous euphoria or indifference.

In other cases the onset is more acute, and the picture of a depressive or an anxiety state may be the first evidence of illness. But after some months hebephrenic deterioration becomes manifest.

2 *Catatonic Group*—These psychoses begin somewhat later, the majority between the ages of twenty and thirty five. There is generally an acute onset, and the clinical picture is either that of a stupor or of a state of excitement. The motor symptoms that have been described dominate the picture, and the tendency to sudden impulsive actions makes these patients most dangerous to themselves and those around them. The psychosis may start with an acute state of anxiety or perplexity, with an abundance of hallucinations and autochthonous delusions. Certain cases of catatonic excitement show manic features which may make the diagnosis from manic depressive psychoses difficult without prolonged observation.

Catatonic psychoses usually subside, but the completeness of the recovery varies, and the type and degree of the residual defect cannot be foretold until the acute symptoms have faded. Recovery may appear to be complete and may last for a considerable period, but ultimately a recurrence usually takes place either in the same form, or in a less acute type of schizophrenia. Recurrent catatonia is a rather characteristic type. Deterioration generally becomes manifest after the second or third attack, as shown by a shallowness of emotion, thought disturbance, or some form of social inadequacy.

3 *Paranoid Group*—These psychoses are the latest in onset, the majority of them starting in the fourth decade. They develop insidiously. Sensitivity and suspicion gradually develop into paranoid ideas, and the development of hallucina-

tions completes the picture. The delusions are not generally systematised and various delusions often coexist without being related or combined. The discrepancy between the grotesque delusions, the terrifying hallucinations and the poor emotional response which they evoke, is often very striking and this may enable the patient to have some insight into his condition. Thus, he may complain 'I am suffering from ideas of persecution', and a German paranoid schizophrenic wrote to his physician during the war 'I have been given the Iron Cross. The schizophrenic indifference is appreciated in the front line.'

The name *paraphrenic* has been given to those sufferers from paranoid psychoses who, in spite of numerous hallucinations and more or less systematised delusional ideas yet retain their personality in a relatively intact state. Thus the patient may show few symptoms of withdrawal or thought disorder, and the emotional rapport may remain strikingly good. Paraphrenic psychoses begin later in life than the other paranoid psychoses, often at the time of the climacteric or the beginning of the involutional period. The preservation of the personality may be due either to the fact that the pre-psychotic personality was of a resistant type, or to the late onset, or to both.

Paranoia is now regarded as a still milder form of paranoid schizophrenia, and the picture is that of a well elaborated delusional system in a personality that is otherwise well preserved. Hallucinations are absent, but falsifications of memory to fit the patient's past into his delusional system are very common. The classical picture is very rare, and takes a very chronic course.

Some paranoiacs live in liberty as queer inventors, founders of eccentric sects or as social reformers, but the majority are ultimately admitted to mental hospitals because of some friction with society.

These clinical pictures represent well known types, but they are not separate entities. When a case is observed for a sufficient length of time combinations and permutations can usually be observed: catatonic outbursts in simple hebephrenic or paranoid states, paranoid developments in hebephrenia, and hebephrenic deterioration after a catatonic psychosis. Observations of this kind provide the decisive argument for the close relationship between all the different clinical types of schizophrenia.

Physical Findings and Pathology—Cyanosis of the extremities, evidence of endocrine dysfunction and various abnormalities of the physical structure are common in all types

of schizophrenia. The closest association, however, seems to be between the asthenic habitus and hebephrenic psychoses.

Degeneration of the cells of the testis has been described in a large proportion of schizophrenics, but no other characteristic anatomical findings have been confirmed.

Biochemical abnormalities are equally elusive, except that it would appear that a disturbance of nitrogen excretion accompanies certain well defined recurrent cases of stupor and catatonic excitement, which enabled Gjesing not only to predict the onset of subsequent attacks, but also to abort them by the administration of thyroxin to increase the nitrogen excretion.

Ætiology—Hereditary factors have already been dealt with (see p. 975).

The changes during puberty and sexual involution appear to favour the outbreak of schizophrenia at these periods of life. Pregnancy and puerperium are most important additional causal factors. Alcoholic hallucinosis has been interpreted as a schizophrenic state following upon and coloured by the alcoholic intoxication. Schizophrenic pictures may also be provoked by cerebrovascular and senile changes in the brain.

The importance of psychological factors in precipitating schizophrenia is often very clear, and the course of the illness may often, to a considerable extent, be modified by psychological influences.

Diagnosis and Differential Diagnosis—The most striking symptoms of schizophrenia do not always possess the highest diagnostic value. Thought disorder and shallowness of emotional response rank first, autochthonous delusional ideas are extremely characteristic, whereas other kinds of delusions, hallucinations and catatonic symptoms are frequent in many other conditions. Yet delusional ideas of a bizarre character, passivity feelings, and especially the complaint by a patient that he hears his own thoughts, are rarely encountered in non-schizophrenic psychoses. So much for the diagnosis from the examination of the patient.

The history and prolonged observation is generally decisive. In order to establish the diagnosis of a progressive schizophrenic illness it is necessary to discover whether the personality of the patient has changed, and if so, whether this change is schizophrenic in character and whether it may or may not be due to environmental or developmental factors. The more extroverted the pre-morbid personality of the patient, the more noticeable will be a change towards introversion, seclusion and emotional shallowness. On the other hand it may be impossible to recognise with certainty minor changes in this direction in a

schizoid, sensitive, shy, shut in type of personality. In such patients it may be difficult or impossible to distinguish mild depressions or neurotic reactions from an early schizophrenia.

The presenting symptoms of a recent schizophrenia may closely resemble those of a state of anxiety, depression, or panic, and the diagnosis may only be permitted or suggested with the development of additional symptoms, especially hallucinations and autochthonous delusions.

The diagnosis of a catatonic from a manic excitement is easy in clear cut cases. But manic features may be present in catatonic states, and then the diagnosis may depend upon the presence or absence of cardinal schizophrenic symptoms. Isolated catatonic features, however, such as stereotypy and grimacing, within a manic picture, must not be regarded as decisive evidence for the diagnosis of schizophrenia. Catatonic symptoms may also result from vascular brain disease. In such cases the discovery of organic signs will decide the diagnosis.

Toxic confusional states may produce pictures very similar to schizophrenic psychoses, but clouding of consciousness is then a marked feature, whereas it occurs only rarely and transiently in the acute form of schizophrenia.

Prognosis—The prognosis of the average case coming under treatment is very serious. It is possible that the outlook is more favourable for mild cases which do not come under psychiatric observation. Follow up studies, conducted ten to twenty years after the first outbreak, show that about two thirds to three quarters of the patients are either dead or permanent inmates of mental hospitals. Even after a period as short as three to four years 40 to 50 per cent are social invalids. After such a period about one third of the patients can be regarded, for all practical purposes, as cured, the remainder are either improved, though not fully recovered, or run a periodic course, with relapses and remissions. About 35 per cent of the cases recover or show a considerable improvement after the first attack.

The prognosis in an individual case is a matter of great difficulty. An old rule, which still holds good, is that the more acute the onset, the better the prospect of a remission. If the onset is insidious, as is usual in cases of hebephrenia, the prognosis is bad. For acute catatonic states the prognosis is more hopeful, though the possible physical complications of both excitement and stupor (exhaustion, physical damage, aspiration pneumonia) must be remembered. Paranoid pictures

tend to progress but special adaptation may be possible in spite of the continuance of the symptoms

The patient's age is of importance only so far as it predisposes to particular types of psychoses. A pre-psychotic personality of schizoid type reacts unfavourably on the outlook, as does a schizophrenic heredity, whereas manic-depressive psychoses in the family may point to a remittent course. The prognosis for patients of a pyknic build is more favourable than for those of asthenic physique or for those who show signs of endocrine dysfunction.

Treatment—As regards treatment the patients may be divided into two classes—those in and those outside mental hospitals. Again in mental hospitals the acute and chronic cases require different treatment. For advice as to general management reference may be made to the general section on treatment p. 993. Chronic cases benefit most by occupational therapy. Wherever this is carried out by up-to-date methods the mute and stiff catatonics who were previously so common are not to be seen. With carefully thought out treatment and management it is possible to bring these patients back to some sort of community life.

In cases of acute excitement continuous narcosis is the method of choice. It prevents the patient from exhausting or damaging himself and is often followed by an improvement in behaviour even if other symptoms continue.

Shock and convulsion therapy can be said to reduce the duration and to improve the outlook of cases of recent origin. Knowledge of their effect upon reducing the chances of a recurrence or upon the final outcome is however incomplete. Still the employment of one of these therapeutic measures is advisable in fresh cases. These forms of treatment should only be carried out in hospital since a trained staff and practical experience in technique are essential and an acute if transient phase may be precipitated by them.

The insulin shock treatment consists in producing a series of hypoglycæmic states and interrupting them after varying periods by oral or intravenous administration of glucose. The intensity of the hypoglycæmia is gradually increased up to deep coma. thirty to sixty comas are produced one each day and treatment is given six days a week.

The convulsive treatment consists in the production of epileptic fits twice or three times a week. This can be done by the intravenous injection of a convulsant drug (cardiazol azoman), or by electrical stimulation of the brain through the intact skull. The more recently introduced electrical method

seems technically the simplest and the least unpleasant for the patient. Fractures of bones and disturbances of memory have been reported after convulsive therapy, and it must always be remembered that an epileptic fit is a serious event.

The relative merits of the methods are still under discussion, but the results claimed for both are equal namely that a recovery rate of over 50 per cent. can be anticipated in cases of less than one year's duration.

Early cases without acute symptoms necessitating admission to a mental hospital, may benefit from environmental treatment, such as change of surroundings and removal of factors which tend to produce sensitivity, hypochondriacal or paranoid ideas. In more advanced cases of the hebephrenic type, and in cases of schizophrenic defect, the main object of treatment is the patient's readjustment to social life. Nothing gives such relief to a patient as freeing him from the stress of an occupation which he can no longer manage, and putting him to a simple task, in which he may once more become a useful member of the community. The longer an attack lasts beyond six months the less likely is recovery.

THE AFFECTIVE SYNDROMES

The increase in knowledge that has taken place during recent years no longer permits of the clearly cut division between manic depressive psychoses, other forms of depression, and neuroses, that was formerly deemed to be possible. It must be realised that, although it is necessary for teaching and classification to describe the affective reactions under various headings, transitional and mixed states not only can be found but occur frequently.

MANIC DEPRESSIVE STATES

According to the classical definition put forward by Kraepelin, manic-depressive psychosis is a mental illness characterised by emotional fluctuations and concomitant disturbances of will and thought. Though the prognosis is good and there is no residual mental defect there is, however, a marked tendency to relapse. Manic and depressive psychoses are grouped together because (1) they may alternate in the same case, (2) some of the striking symptoms may be regarded as exact opposites. The symptoms of manic depressive psychoses

are both physical and mental and are given in tabular form below —

Depressive States

- 1 Sadness
- 2 Motor retardation up to stupor
- 3 Retarded thinking
- 4 Delusions of self reproach, depersonalisation, hypochondriasis
- 5 Suicidal ideas
- 6 Loss of sexual desire
- 7 Sallow complexion

Manic States

- 1 Elation
- 2 Hyperactivity
- 3 Flight of ideas
- 4 Delusions of grandeur, mental and physical
- 5 Aggression
- 6 Increased sexual desire
- 7 Ruddy complexion

Loss of weight, constipation, insomnia and, frequently, amenorrhœa, are found both in manic and depressive states

Within the manic-depressive psychoses various types may be distinguished —

1 Depression with retardation classical melancholia which, in its most severe forms, passes into depressive stupor

2 Hypomania and mania

3 Depression without retardation mixed states with anxiety, agitation, and hypochondriacal and paranoid features
All these features are common in involutional melancholia

The depressive phase of manic depressive psychoses (melancholia) usually begins and ends gradually. The cardinal symptom is the depressive mood. The patient feels sad, or listless and apathetic. Anxiety is frequently combined with the depression and the patient complains of pressure in the head, precordial sensations and a sense of oppression in the chest or abdomen.

The melancholic mood colours the whole outlook on life—past, present and future—pessimistically. The patients worry about their economic condition and their own prospects, as well as those of their wives and children. They tend to turn their fears into facts so that they may come to believe that they are financially ruined, or that their families are starving, sick, or even dead. This may go on to nihilistic ideas that they are themselves dead and that the world does not exist. But these nihilistic ideas may also originate from the hypochondriacal pre occupations that are very common in melancholics. They complain that their organs do not work, that their stomach cannot digest food, that their bowels are blocked, that their heart does not beat, that their genital organs are decayed. Sometimes instead of feeling that they themselves

are changed (depersonalisation) the outer world appears different (derealisation) In depersonalisation the patient feels different from what he used to be, strange, lifeless, detached, automatic In derealisation the outer world looks dead or macabre In "affective loss" the patient complains of loss of feeling, often given a self reproachful twist, e.g., he feels "hard hearted" All transitions and variations may be found

Melancholic patients are inclined to blame themselves for their condition, and feelings of guilt and self reproach are most characteristic features The patient looks into his past, and there finds causes for regret and self reproach Falsifications of memory on these lines are not infrequent The self reproachful ideas generally follow the popular views of moral and medical causation, and thus the illness is attributed to masturbation, or lack of consideration and love or some other "sin," real or imaginary

Paranoid delusions often develop from the self reproach, so that the melancholic comes to believe others look at him, and indicate his unworthiness by word, look or gesture Hallucinations are exceptional, but illusions and misinterpretations frequently occur The paranoid ideas are consistent with the mood and appear comprehensible in the light of the patient's attitude and outlook Obsessional features are often present, even when the patient had none before the illness

Suicide—Every melancholic patient must be regarded as a suicidal risk and many patients are admitted to hospital after suicidal attempts These patients may plan suicide carefully and dissimulate their intentions Whilst in hospital, strangling, hanging and jumping out of the window are the favourite methods, at home patients frequently try to gas themselves or to swallow poisons The morbid fear for the future of their dependents sometimes leads to well intentioned homicide before a suicidal attempt, and this may lead to an especially tragic situation if the shock of the homicide prevents the intention of suicide being carried into effect Suicide would probably be more frequent in melancholic patients were it not that another cardinal symptom *retardation* (*vide p 979*), has a somewhat antagonistic effect

The retardation may only be noticeable to the patients themselves, who find that every thought, word, movement, or decision requires a greater effort than normally If, however, retardation becomes more marked, the slowness may become apparent to the outside observer In the most severe form a condition of melancholic stupor results

Retardation cannot be regarded as the simple accompani

ment of the depressive mood, for the retardation and depression may vary independently of one another, and not infrequently retardation improves before the depression. This explains why the risk of suicide is specially great during the period of recovery, even greater than at the height of the illness. Again retardation may be more marked than the depressive affect throughout the illness, and it is generally regarded as possessing greater diagnostic significance in so far as the endogenous type of depression is concerned. The intensity of the symptoms may vary with or without an obvious external cause. It is very common for depressions to be worse in the morning and to improve somewhat towards the evening. This morning and evening variation is often connected with the disturbance of sleep, but many patients complain of feeling worse after a good night.

The insomnia of depression is characteristic in that the difficulty is not so much in going off to sleep, as in waking up early. Sexual desire is diminished or absent, and impotence is frequent, even in the early stages, which may lead to hypochondriacal and self-reproachful elaboration. Loss of weight is another very constant feature, and although the loss of appetite usually leads to reduced intake, it can be shown that this does not wholly account for it.

Other physical findings are of less importance. The blood pressure tends to be somewhat higher than is normal for the individual, and nearly all depressives complain of constipation.

Mild forms of melancholia may be disguised as "organ neuroses," i.e. vague complaints of indigestion, constipation and precordial sensations may be the most conspicuous symptoms. Closer investigation may disclose insomnia, and a certain amount of retardation with or without manifest depression. A history of previous phases of mania or depression may be elicited.

Mania—In many respects the symptoms of mania may be regarded as the exact opposites of the symptoms of melancholia. The dominating affect is elation, and the patients are gay, cheerful and feel better than ever before. But they are often irritable as well and this may be one of the most prominent features throughout. Sleeplessness and irritability are often the first symptoms. These emotional symptoms are coupled with overactivity. The patients start to do more, undertake larger enterprises and indulge in greater risks. The increasing number of these new enterprises soon makes it difficult for any one to be completed. In severe cases, activity becomes disconnected and purposeless. Impulses follow one another

in rapid succession, and the manic patient can brook no interference or restriction and becomes aggressive and violent. At the height of manic excitement, consciousness may be dimmed and the patient may become completely exhausted. Flight of ideas as opposed to retardation is the characteristic disturbance, and the patients talk, shout, or sing incessantly. Jokes and rhymes, accompanied by vivid and expressive movements, are poured forth. Manic patients are very distractible and weave everything they see or hear into their utterances. Grandiose ideas may be developed, but are usually put forward in a jocular vein. Some make hypochondriacal complaints, but utter them with manic vigour. Hallucinations are rare, and if present, are in keeping with the grandiose ideas and the elated mood. The increased sexual desire and lack of inhibition may result in all sorts of difficulties. Manics may for a time present the picture of perfect health, but soon signs of exhaustion and starvation become evident.

Hypomania shows the same symptoms as mania, but to a lesser degree. It is therefore more difficult to recognise, and it is often most difficult to convince a lay person or a judge that the cheerfulness, overactivity, lack of control, and argumentative irritability are evidence of a morbid condition.

Manic depressive states do not always conform to the classical picture that has just been described.

It is most important to bear in mind the possibility of minor attacks, and a carefully taken history will often reveal mild phases of depression or elation that were never regarded as illnesses at all.

Again, the symptoms may appear in different combinations to those seen in classical melancholia and mania. The existence of these intermediate or mixed forms is shown very convincingly in *manic stupor*. In this extremely rare condition patients may exhibit a most striking lack of manifest activity, but after recovery they describe their euphoria and flight of ideas which they were unable to express owing to their extreme motor retardation.

Depressions without retardation or even with excitement (*agitated melancholia*) can also be regarded as examples of mixed forms which, however, have great practical importance because of their frequency. They are most commonly seen in the involutional period, but can also occur at a younger age. These patients are tense, anxious and fearful rather than sad, and the corresponding affects colour or dominate the clinical picture, which can be that of extreme restlessness and agitation with much sobbing, wringing of hands, and incessant complaint.

and lamentation. Owing to their lack of retardation they can be dangerously suicidal.

An absence of retardation is also often regarded as one of the most characteristic features of *exogenous* depression, but the difference between *exogenous* and *endogenous* depressions on this point—as in all other respects—is one only of degree. The symptoms in a typical *exogenous* depression follow immediately upon some event which makes the reaction comprehensible in the light of the patient's personality and circumstances, the abnormality of the emotional reaction consisting in its duration and intensity. Throughout the illness the patient is only concerned with this causative event or situation and its possible consequences. Thus he will brood over how it came about or might have been prevented, blaming himself or, more typically, others for sins of omission and commission. Finally, an improvement in, or adaptation to, external circumstances tends to lead to a more rapid recovery than is seen in *endogenous* conditions.

Few patients fulfil all these criteria for an *exogenous* depression, and the number is further reduced if the latent fallacy of a "spurious psychogenesis" (see p. 967) is clearly recognised.

Involucional depression is often diagnosed (a) if the illness starts about the involutional period, and (b) if the patient has never previously suffered from a manic or depressive phase. The main features are agitated depression with much apprehension and anxiety, hypochondriacal ideas, often of a bizarre character, a preoccupation with the theme of death, and various paranoid reactions and paranoid delusional formations. The usual depressive delusions may be present as well. Exactly the same clinical picture may, however, occur in manic depressive states at this time of life, in which the original personality is probably an important determinant.

Course—Cases of classical recurrent type usually start between the twenty-fifth and fortieth year. Depressive states are more frequent than manic, and in more than two-thirds the first attack is a depression. Two-thirds of the cases recover completely, the rest swing over into the opposite phase before recovery. A considerable number have only one clear-cut attack. It is impossible to predict what intervals will elapse between attacks in those that have recurrent illnesses. The duration of individual attacks varies enormously. As a rule they last between six and eight months, but attacks of two or three weeks' duration may occur, as well as those that last two or three years. In the interval, the patients appear well, although mild hypomanic features may be noticed by relations.

after depressive illness, or some moroseness after a manic state. After several attacks, such alternations in mood may be observed more frequently, and it is then sometimes difficult to judge whether these patients suffer from a series of minor mood fluctuations, or from a definite change of personality.

The Prognosis.—For the individual attack the prognosis is good, but recurrence is probable. Advanced age, arterio-sclerotic features, or atypical (schizophrenic) psychoses in the family, are all points that should lead to greater prognostic reserve. Retardation is the symptom which has the highest correlation with a good prognosis.

The prognosis is always more serious if the first attack occurs at the involutional period. The duration of an involutional depression is often given as between nine and twelve months, but many cases last a much longer time. As has been pointed out, the course and duration of an exogenous (neurotic) depression are more closely related to the event or situation which was responsible for its production. It must, however, be remembered that both manic and melancholic states of endogenous type may be precipitated by emotional shock or stress, and the subsequent illness may last as long as did previous attacks which were not so precipitated. The characteristic feature of these endogenous illnesses, precipitated by psychological factors, is that the content tends to lose connection with the precipitating event. These points must, however, be taken as guiding principles rather than as rigid rules, for even in the most endogenous cases, the content of the depression must necessarily be determined to a considerable extent by the patient's past experience and circumstances, and even when a depression appears psychologically comprehensible as a reaction to some external event, the type of the patient's response is largely affected by constitutional factors. It is therefore necessary to study each case individually before the relative importance of constitutional and environmental factors, and their bearing on the prognosis, can be assessed.

Ætiology.—The constitutional factors are demonstrated in the heredity, in the pre-morbid personality, and in the patient's physique. Manic depressive psychoses are much more frequent in women than in men. The climacteric is an important precipitating factor. A certain number of cases develop after childbirth. It is now recognised that there is no specific puerperal insanity and breakdowns occurring at this time may be of any type. It is not rare to hear from patients that they were always liable to mild depressions at the time of their menstrual periods. In other cases the onset occurs after severe

infections, especially influenza. Manic depressive psychoses are quite frequently precipitated by strokes, and this lends some colour to the belief that severe head injuries may be important as well. There is little doubt that the psychological situations arising out of accidents—mutilation, prolonged hospitalisation, loss of employment—may cause depressions, but hysterical elements often predominate in such cases. The importance of psychological factors and experiences has already been mentioned.

Differential Diagnosis—The differential diagnosis between the various types of depression can be limited to the assessment of the relative importance of endogenous and environmental factors. Hysterical and obsessional features are not inconsistent with the diagnosis of depression, but they are of great importance for the prognosis in the individual case. Affective pictures may disguise the early stages of schizophrenia. Retardation and schizophrenic anergia must be carefully distinguished. Hypochondriacal and paranoid ideas, if in keeping with the affective state, also do not preclude the diagnosis, but if they become bizarre or incomprehensible in the light of the prevailing mood, they point to a schizophrenic illness. Again, shallowness of affect should arouse the suspicion of schizophrenia. Demonstrative statements of being depressed may be part of an hysterical reaction. Depressive pictures also occur in organic conditions such as general paralysis. High blood pressure, or evidence of arterial thickening should suggest the possible role of vascular disease, but organic dementia is often difficult to demonstrate if retardation dominates the picture. Manic states must be distinguished from catatonic excitement, a euphoric mood, contact with the surroundings, and distractibility are in favour of the former diagnosis, whereas stereotypy, mannerisms, and negativism speak for schizophrenia. As with depressive pictures, the possibility of organic conditions, such as general paralysis, must be borne in mind.

Treatment—Any physical factors must, of course, be dealt with in so far as this is possible. The management, psychological treatment, and psychotherapy in general have been dealt with elsewhere (*vide p 996*). All depressive patients require reassurance, and mild cases usually respond well to it. As a general rule it can be said that the more reactive the case the more is psychotherapy indicated that includes a thorough psychological investigation of the patient's problems and their reformulation with a view to helping in his readjustment.

Some chronic depressions, particularly those of the involuntary type, seem to respond well to convulsion therapy, an exact indication for this treatment in cases of depression cannot yet be formulated

ANXIETY STATES

Anxiety is a symptom which may occur in any psychiatric syndrome. In some affective reactions, however, the anxiety syndrome occurs in more or less pure culture. The ambiguous term "anxiety hysteria" is better avoided altogether. Anxiety, if used as a psychiatric term, denotes a condition of fear not clearly focussed on any special object, accompanied by striking physical signs similar to those produced by the secretion or increased output of adrenalin, such as dilation of the pupils, rapid pulse, palpitations, rise in blood pressure, sweating, pallor, and tremor. The patients may complain of these physical effects when they intrude upon consciousness, or of other sensations more or less closely connected with what may be called the "adrenalin syndrome": dryness of the mouth, feelings of choking or suffocation, sighing, restlessness, fatigue, weakness in the limbs, feelings of fainting, frequency of micturition. The sensations of suffocation may induce overbreathing, which may in its turn lead to the symptoms of hyperventilation tetany, such as tingling in the fingers and toes, muscular spasm and, finally, some blurring of consciousness. The symptoms of an anxiety state are often, of course, further increased by self observation and misinterpretation, leading to the development of a vicious circle.

Anxiety may occur in acute attacks, the first of which can often be traced back to some special experience. Subsequent attacks may then be provoked by any happening which comes to be associated with the original trauma, more and more events come to be so associated, so that finally the "conditioned reflex" is set going by some very slight stimulus with no obvious connection at all. This episodic or recurrent type of anxiety merges into the chronic anxiety state where the same symptoms, though generally milder in degree and varying in intensity, continue for long periods. Sufferers from episodic or recurring types of anxiety are seldom completely free from symptoms in the intervals between their attacks, but are irritable, tense, dissatisfied, and unhappy.

The term "anxiety state" should not be applied too loosely to any case that shows the symptoms. This mistake is often made, so that a large number of conditions are included that

should be dealt with separately. Thus, as has already been mentioned, anxiety may be the predominant affect in depressive or schizophrenic illnesses. Again, patients who suffer from phobias, as the result of which they fear to do something lest anxiety may supervene, are better described under the heading of "obsessional neuroses," to which they are clinically related by other features. Finally, anxiety states and their physical accompaniments may be intensified or prolonged by psychological mechanisms of an hysterical type, involving some secondary gain, i.e., the wish to escape from some difficult situation. Thus anxiety states can, and often do, blend into hysterical reactions, just as do certain physical illnesses, as when organic paralyses are complicated or prolonged by hysterical developments and mechanisms. The term "organ neuroses" is often used when the main symptomatic emphasis is concentration upon some one or other of the physical accompaniments of anxiety. It must, however, be stressed that not all "organ neuroses" are of this type. Some may be regarded quite simply as abnormal "conditioned reflexes" others are clearly hysterical from the start, either because they express some emotion metaphorically, or because they serve some personal purpose. Anxiety symptoms are only biologically and not personally purposive. It is probable that, of all the "organ neuroses," the cardiac neuroses bear the closest relationship to anxiety states, for the accelerated or forceful action of the heart is peculiarly prone to make a striking impression upon the patient's mind. As he is often inclined to "repress" the real cause of his anxiety, he readily finds his way to the heart specialist to whom is often left not only the differential diagnosis but the treatment of these states. In the same way it is probable that the striking physical accompaniments of sexual excitement account for the ready conversion of psychological disturbance in the sex life into the symptoms of anxiety.

Ætiology—The physical accompaniments of anxiety have been experienced by nearly everybody. Although the threshold varies, the symptoms of an acute attack of anxiety can be produced in the most normal individual when a sufficiently large dose of adrenalin, caffeine, benzedrine or some similar drug is injected. The development of the symptoms of anxiety is therefore a potentiality which we all possess, and this may explain why anxiety states should be the most common of all the neurotic reactions and the least dependent upon the constitutional background. It is important to bear in mind the general principles of psychiatric ætiology which were outlined on p. 966. As regards psychogenesis, the psychoanalytical

school has proffered the formula "morbid anxiety means unsatisfied love" That this can be the correct explanation in certain cases need not be doubted, but it is generally held that this formula is too narrow, and that any conflict endangering the moral or social standards of the individual can result in the production of anxiety states The war neuroses have demonstrated this on a large scale The sufferers are usually unaware of the true nature of their conflicts or at least do not face them openly They hence tend to turn their attention to their less vital problems, namely, their symptoms This indicates the line of *treatment* that should be adopted The patient has to be led to realise the true basis of his difficulties and to readjust his standards to the requirements of his social environment in so far as the latter cannot be adjusted by him or for him. In the treatment of the individual anxiety attack the importance of the physical factors suggests an approach from the physical side Drug treatment is indicated not only on theoretical grounds but also because of its success in practice Bromides and hypnotics are of great benefit to the patient, and may indeed be necessary to tide him over the acute stage in which he will not be accessible to psychotherapy In the severe cases of terror and panic as observed during the war, continuous narcosis has proved to be the most efficient method for this purpose

HISTERICAL REACTIONS

The term "hysteria" or "hysterical" is one of the most ambiguous and misused in the whole of psychiatric literature It is commonly confused with the conception of "psychogenic," or, in other words, is employed to denote everything that is psychological in origin It should however be restricted to those psychogenic reactions which are kept going for the sake of some gain which the illness brings in solving some problem, or in fulfilling some wish, or in satisfying some desire in reality or in phantasy In brief, it should be restricted to those psychogenic reactions which serve some personal purpose This definition excludes such symptoms of psychological origin which are merely exaggerated accompaniments or metaphorical expressions of normal or abnormal emotions The conception of psychogenic is therefore a wider one than that of hysterical, and includes such reactions as vomiting as an expression of disgust This need not be hysterical, but becomes so if it is used for such a purpose as getting rid of a pregnancy The patient is never clearly aware of this motive The amount

of self-deception that is practised in hysterical reactions varies greatly, and all transitions between hysterical reactions and frank malingering occur. It would, however, be a mistake to suppose that frank malingering is at all common for, as has been rightly said, this would be a naive underestimate of the capacity of human beings to believe what they think is in their own interest.

Ætiology—Hysterical symptoms usually develop on the basis of some constitutional predisposition. The predisposition may be greatly increased by experiences, especially the experiences of early life. Hysterical reactions are more common in women than in men, puberty is a favourite period, and emotional immaturity is often a striking feature of hysterical patients. The secondary sexual characteristics are frequently underdeveloped. Abnormal suggestibility on the mental side and lability of the vegetative system on the physical side are characteristic findings. Together they are probably responsible for the readiness with which hysterics convert psychological into physical symptoms. This "conversion" is a normal psychophysiological happening, we know, however, very little about the actual mechanism.

The hysterical personality has been described on p/ 1004. The symptoms of an hysterical illness may be either physical, or mental or both. Physical symptoms may imitate those of almost any type of illness. Hysterical blindness, deafness, loss of cutaneous sensation, paralysis, spasms, tremors are some of the usual gross manifestations, the differential diagnosis of which will be found in the description of the corresponding physical diseases. But the hysterical imitation of an illness is generally a very rough one, since it corresponds to the idea that the patient has of the symptoms of the illness. Thus, hysterical anæsthesias are generally of the glove and stocking type, i.e., they are limited to what the patients think is a functional unit. With the spread of medical knowledge among the general population, gross physical manifestations tend to decrease at the expense of vaguer and subtler complaints such as headaches, giddiness, or feelings of faintness. Patients as a rule adopt a characteristic attitude towards their symptoms, either putting up with them with the classical "*belle indifférence*," or demonstrating them ostentatiously. There are all transitions between trembling, shaking, and twitching, and the hysterical fit, the manifestations of which may be greatly changed by external circumstances, another aspect of the increased suggestibility. Thus, the typical stages described by Charcot were certainly an artefact of

the Salpêtrière atmosphere. The motor phenomena often utilise physiological mechanisms, and it is therefore, often difficult to distinguish between hysterical and extra pyramidal symptoms, such as choreiform movements. In other instances the fit starts by overbreathing, and is coloured by phenomena due to the disturbed acid base balance, such as clouding of consciousness and tetany, or kindred symptoms. Simple vaso motor collapse (fainting), though not hysterical in itself may be used within an hysterical neurosis. The distinction between the hysterical and epileptic fit is discussed on p. 871.

The mental manifestations of hysteria are twilight states, trances, fugues and hysterical amnesia. The frequent utilisation of anxiety symptoms as part of an hysterical reaction has already been stressed.

Hysterical Twilight States (often called Ganser) are mainly observed in prisons. They consist of a mild disturbance of consciousness and the symptoms are such as a lay person imagines a lunatic to show. Answers to all questions are so beside the point, or wrong in such a way, as to give a clear indication that the correct answer must exist somewhere in the patient's mind. Sometimes the condition passes into hysterical stupor, which may be difficult to distinguish from catatonic stupors, though generally vital functions are not so involved as in the latter condition. The discovery of situations which the patients had to face, but which they try to evade, may be helpful in the diagnosis, but it must be remembered that catatonic psychoses may also be precipitated by imprisonment, or the mental stress of the legal procedure.

A *Trance* is a dreamlike state which may be produced by suggestion or by emotional shock. Physical factors may assist in its production as when small doses of hypnotics are given to make the patient drowsy, or after hyperventilation which normally produces a mild alteration of consciousness. The mechanism for the production of trance may be facilitated by practice and some mediums readily pass into this condition. During trance so called automatic actions may be carried out, sensory perception may be altered and hallucinations may be experienced. There is often a very vague recollection afterwards or there may be a complete amnesia.

The term *hysterical fugue* is used for patients who wander whilst in such states, they may be found far from their own homes, not knowing who they are or how they got there. Adequate reasons for such disappearances can usually be discovered.

Pathogenesis—Many theories have been put forward to

explain the mechanism of the hysterical reactions, some psychological, some physical, and some a mixture of both. It must be assumed that the physical symptoms have a physiological basis, and some of the physical mechanisms at work can be demonstrated. Yet a psychological factor is always necessary to set these physical mechanisms going, and in hysterical reactions there is always a flight into illness, or a defence mechanism with the object of gaining security or justification, that is not fully obvious to the patient.

A satisfactory and general solution of the problem as to how psychological factors become converted into physical symptoms is as impossible as an explanation of the relationship between mind and body. The symptoms may be explained as the results of suggestion, but for this a condition of increased suggestibility must be assumed, or the reactions may be regarded as analogous to conditioned reflexes that are ground in by repeated elicitation. According to psychoanalytical views, the symptoms are due to affective energy originally belonging to some repressed material, and the symptoms produced express symbolically the repressed wishes or their gratification. It should be borne in mind that a medical examination increases suggestibility, and that hysterical manifestations are not infrequently the direct result of medical mismanagement.

Prognosis—The prognosis of the individual hysterical reaction is good, but the prognosis for the hysterical disposition is more serious and more difficult to assess. The disproportion between the stimulus and the reaction in the present illness or in previous illnesses, should these have occurred, may be used as a guide. Patients who have broken down in response to a negligible stress are more likely to relapse than those who are defeated by a severe strain. When frequent hysterical reactions have been shown the outlook for the future becomes worse and a marked hysterical character (see p. 1001) makes the prognosis more grave. Hysterical reactions in childhood or adolescence are less serious. Individual attacks yield more readily to adequate treatment, and the predisposition towards an hysterical response may be influenced from the environmental side, and very often diminishes or disappears after puberty.

Differential diagnosis of hysterical symptoms of a physical kind may be very difficult. The distinction between hysterical and epileptic fits has been discussed on p. 871. Hysterical tics, tremors and twitchings may be very similar to choreic or to extra pyramidal syndromes. The influence of emotions

and suggestions on the symptoms must be observed carefully, and a sound knowledge of neurology is necessary. The greatest difficulties are met with in those cases with organic lesions that recover, where, however, the loss of function is maintained by hysterical mechanisms, as is frequently seen in disseminated sclerosis.

Treatment—Hysterical mechanisms are a field for suggestive therapy of every kind, but the symptoms are likely to recur in the same or in a different form unless an attack is made on the basic psychological problems, or unless the environmental stress diminishes. It is therefore necessary to analyse the difficulties that have been experienced in the adaptation to life, and it should be remembered that hysterical qualities may be of value in the patient's readaptation. Many hysterics do very well in positions where they may play act, or duly come in for self-demonstration or sacrifice, or where work permits them to find such attachments as they were previously unable to form.

War neuroses and *compensation neuroses* are special examples of hysterical reaction. In the former instance the wish to stay away from the front line, and in the latter the attempt to obtain or to keep compensation clearly provide reasons why the morbid symptoms remain. The symptoms of these neuroses are the same as those found in other hysterical conditions, but are often much less dramatic in presentation, and may be mixed with those of an anxiety state. Fugues and amnesias have been found to be relatively frequent types of reaction in this war, and usually respond well to narco analysis so far as the removal of the symptoms is concerned. Compensation neuroses seldom improve while any uncertainty as to the compensation remains and if they do not improve after that, a thorough investigation of the patient's life becomes necessary, and readaptation according to the result of this should be attempted, aided by suggestive treatment for the particular symptoms that are shown.

OBSESSIONAL STATES

Obsessions have been defined as "contents of consciousness which, when they occur, are accompanied by the experience of subjective compulsion, which cannot be got rid of, though on quiet reflection they are recognised as senseless" (K. Schneider).

Minor obsessional symptoms, such as having to count objects, are not unknown among normal individuals. All

children tend to ritualise, and nearly all of us have our scruples, and indulge in a special order when we dress or undress.

Obsessions are generally divided into obsessional ideas, impulses and phobias, and, as has been mentioned, the latter bear a close relation to anxiety and anxiety states. The object of the phobia varies and some types have been given special names, such as claustrophobia, agoraphobia or even erythrophobia, or fear of blushing. Fears of bacteria, or of swallowing harmful substances, or of being soiled, or of touching knives are other typical examples.

Obsessional impulses show the same variety. Some patients feel forced to touch everything, or to count or to arrange things in a special order. Impulses to commit suicide or homicide are generally mastered unless the obsessional state is complicated by the features of some other syndrome, such as depression. Obsessional patients, in contrast to schizophrenics, struggle against their impulses. Many patients elaborate defence mechanisms against their obsessional impulses and substitute more harmless actions for those that cause them fear. There is a tendency for these ceremonials to become more and more complicated, which makes the behaviour of many patients with obsessions appear very odd. Similar ceremonials and defence mechanisms develop out of phobias, and patients with a fear of dirt or disease may feel impelled to wash themselves whenever they touch anything, others wear gloves or adopt more complicated devices. Compulsive utterances may also occur, sometimes consisting of meaningless words or phrases, but very often having a manifest or very slightly disguised content of an obscene kind. The impulse to swear, or to blaspheme, or to be obscene, may be aroused by religious pictures or crucifixes. The obsessional ideas and thoughts may be verbal or musical, or may take the form of visual imagery or pictures. The repetition of meaningless phrases or questions such as "Why is that so?" "Why is God?" "Why is the world?" "Why is not nothing?" may become a torture. Others develop doubts and scruples about what they have done, or should do, and must return constantly to see whether the door is shut or the gas turned off, but the doubt still remains. They have to repeat calculations and make careful notes to see that all is done in proper order. One patient felt impelled to write out the next day's programme in shorthand the night before, taking some hours over this task.

Ætiology — The pre-morbid personality of obsessional patients frequently shows minor obsessional traits. But these

and similar traits not only occur in those who never become mentally ill, but also occur in patients who develop mental illnesses that are not of an obsessional type. This makes the ætiological significance of such factors rather limited. Heredity plays an important part, and one third of the parents of obsessional patients and one fifth of their siblings have pronounced obsessional traits. The obsessional symptoms can often be traced back to wishes and experiences that have given rise to painful emotions, and have therefore been repressed. The repression is kept up by the strict self-discipline that is so characteristic of the obsessional person. These psychological considerations do not explain why the results of repression take an obsessional form, and it is usually assumed that they develop on a constitutional background. But obsessional symptoms may occur in organic brain disease in patients who have shown no sign of constitutional predisposition. The close connection between obsessions and paroxysmal neurological symptoms, such as the oculogyric crises of post-encephalitic Parkinsonism, makes it probable that in these cases there is a close connection between the psychological and physiological events.

Prognosis—The prognosis for an obsessional illness depends on the setting in which it occurs. When obsessional symptoms are present or when obsessional characteristics become more acute within the setting of a depressive state, the prognosis is good. Certain patients have one or more recurrent obsessional upsets without much evidence of depression. But when the onset is gradual, the progress slow, and when the symptoms tend to become more and more elaborate, the prognosis is poor. Severe obsessional symptoms may preclude the patient from all work and social activity, and induce a life of seclusion scarcely to be distinguished from that of a schizophrenic illness. Severe obsessional symptoms in youthful individuals not infrequently pass into a definitely schizophrenic illness later.

In a follow up study, made many years after discharge upon an unselected group of obsessional patients it was found that one half were well, one third stationary or worse and the remainder ran a fluctuating course (Aubrey J. Lewis).

The *differential diagnosis* in chronic obsessional neuroses from schizophrenia may be difficult for the emotional response of such patients is often poor and queer. It is essential for the correct diagnosis that the criteria for an obsession should be fulfilled, and that the compulsion should be fought against and not projected as something coming from the outer world.

The *treatment* will depend on the setting. Patients with

depressive components must be treated like depressive states. A carefully planned régime assists some patients to overcome their difficulties, and a change of surroundings—such as admission to hospital—often leads to some improvement. Prolonged psychotherapy can hardly claim more therapeutic success than that achieved by the more reserved activity of an out patient department.

THE LEGAL ASPECTS OF MENTAL ILLNESS

ADMISSION OF PATIENTS TO MENTAL HOSPITALS

A patient may be admitted to a mental hospital, or other premises approved by the Board of Control, (1) as a voluntary patient, (2) as a temporary patient, and (3) as a certified patient.

1 **Admission as a Voluntary Patient**—The patient has to sign a form of application expressing the desire to be treated as a voluntary patient, with the understanding that, should he desire to leave, he may do so on giving seventy-two hours' written notice to that effect. No other formalities are required. If the patient is under the age of sixteen, a parent or guardian has to sign the form of application which, in this case, must be accompanied by a medical recommendation.

2 **Admission as a Temporary Patient**—This method also avoids certification, but is only applicable to a patient with a good prognosis who is likely to benefit from the treatment, and who is "incapable of expressing himself as willing or unwilling to receive such treatment." Unfortunately only a small percentage of patients fulfil these criteria.

An application has to be made by the husband, or wife, or near relation, and two medical recommendations are required, one to be signed by a medical practitioner approved by the Board of Control for the purpose, the other, if possible, by the patient's usual medical attendant. The practitioners may examine the patient separately, but within seven days of each other, or together, and the medical recommendations are valid for fourteen days after the date of the later of the two examinations.

The primary period of detention must not exceed six months, but if signs of impending recovery are evident, the detention may be extended, by three monthly periods, up to a year from the date of admission.

3 **Admission as a Certified Patient**—There are four methods of certification in England, and it is convenient to consider

them (A) as applicable to private patients and (B) as applicable to rate aided patients, i.e., patients who cannot afford to go to private institutions, but must go to rate aided hospitals

A For Private Patients—(1) *By Reception Order on Petition*—Five separate documents are required—

- (a) A petition addressed by the nearest relation to the appropriate judicial authority, usually a Justice of the Peace, especially authorised for the purpose
- (b) A Statement of Particulars, i.e., age, profession, etc., of the patient
- (c) and (d) Two Medical Certificates, one of which should, if possible, be signed by the patient's usual medical attendant. The medical examinations must be carried out separately, and must be made within seven days of the presentation of the petition
- (e) The Reception Order, which must be signed by the judicial authority to whom the petition is presented

(2) *By Urgency Order*—Three documents are necessary, but are all available on one form—

- (a) The Urgency Order addressed to the Medical Superintendent, or person in charge of the institution, to which the patient is sent. This must be signed by the nearest available relative
- (b) A Statement of Particulars, as in (1)
- (c) One Medical Certificate

The Urgency order remains in force for seven days, and during this period the patient may be discharged, or alternatively, he may be certified according to the procedure laid down in (1)

This method has great value when the problem of dealing with the patient is an urgent one, for it avoids the delays that nearly always attend full certification

(3) *By Summary Reception Order*, and (4) *By Inquisition*—The former is a method available for non rate aided patients in special circumstances, i.e., when found wandering at large, or neglected, or cruelly treated by their relatives. The latter method is hardly ever used, except when large and complicated financial issues arise. Details should be sought in textbooks of medical jurisprudence

B For rate-aided patients (not private) the method is by *Summary Reception Order*. The necessary forms for admission comprise an order of a Justice of the Peace, a Statement of Particulars, and one Medical Certificate

In practice, when a patient cannot afford an institution for private patients, the medical attendant should advise the relatives to notify the Relieving Officer of the district (his address can, if necessary, be obtained from the police). It is well to give the relatives a note to the effect that the patient is a fit case for removal to the observation ward, with a brief outline of the reasons that have led to this conclusion. The Relieving Officer will then make the necessary arrangements. Such a note is not a certificate.

The reasons for certifying a patient have been summarised as follows —

- 1 To protect the public from injury
- 2 To protect the patient from self injury
- 3 To give treatment with a view to cure or amelioration which cannot otherwise be given
- 4 To protect the patient from injury resulting from want of care

All the documents connected with certification must be filled up with meticulous care, and reasons have to be given in the medical certificate not only for the patient being of unsound mind but also for his being 'a proper person to be detained under care and treatment'. Certificates should only give plain statements of fact and should be couched in non-technical language. The diagnosis is not required and should not be given. Facts observed by the examiner must be distinguished very clearly from the facts communicated by others. The ideal certificate is one that would convince the most stupid and bigoted member of a jury that the patient was insane.

Persons signing medical certificates will not be liable to any civil or criminal proceeding if they act in good faith and with reasonable care."

CRIMINAL RESPONSIBILITY

A person who is found to be insane at the time of trial shall not be tried (Criminal Lunatics Act, 1880). When during the trial of an accused person he is found to have been insane at the time of the commission of the act, the jury shall if satisfied that he committed the offence, return a verdict of 'Guilty but insane'. In either case the person may be detained in custody during His Majesty's pleasure.

In dealing with insanity, the Courts follow the rules laid down by the judges in connection with the case of *McNaughton*, a paranoid patient who had been tried for the wilful murder

of Sir Robert Peel's private secretary The important points in these rules are —

- 1 "In order to establish a defence on the ground of insanity, it must be clearly proved that at the time of committing the act the party accused was labouring under such defect of reason from disease of the mind as not to know the nature and quality of the act he was doing, or if he did know it, that he did not know he was doing what was wrong"
- 2 "If the accused labours under 'partial delusions' only, and is in all other respects sane, he should be considered in the same situation as to responsibility as if the facts with respect to which the delusion exists were real"

Modern psychiatry would object to the basic conceptions of both these rules Thus, the idea of partial insanity contradicts the present view that mental disease is a disorder of the total personality, and it is now believed that instinctual and emotional factors are much more important in controlling a person's actions than are intellectual processes or rational considerations However, these rules are still applied in court

CIVIL LAW

The question of insanity may arise in all provinces of Civil Law, but only three points will be mentioned here —

1 **Management of Property**—If a person is apparently unable to manage his property by reason of mental disorder, a guardian may be appointed for him, and the Master in Lunacy is empowered to exercise jurisdiction over the estate of mental patients and, if necessary, to appoint a receiver

It is possible under Section 116 of the Lunacy Act 1890, for a doctor, who ought to be the patient's usual medical attendant, to write a certificate to the effect that the patient is incapable of managing his affairs "by reason of mental infirmity arising from disease or age," and this can be made to apply to those who are not certified This provision is extremely useful for senile patients and for certain other conditions

"If the patient is lawfully detained the Master is in a position, if he thinks it desirable to make an order without requiring any medical evidence"

2 **Testamentary Capacity**—This is not an uncommon question in examinations The medical man should satisfy himself on the following essential points Does the patient

(1) understand the nature of a Will, (2) the effect of a Will, (3) appear to have a reasonable knowledge of his estate and has he any delusions thereon, (4) has he the capacity to appreciate what dependents, relatives, or friends might reasonably be entitled to his bounty, (5) has he any delusions which would *per se* cause him to omit any person or persons as beneficiaries, who otherwise might reasonably have been included, (6) has he any delusion which would cause him to make a gift which he might not have made in the absence of such delusion, (7) does he appear to understand the importance attached to his act, (8) if the medical practitioner sees the draft of the will, do the bequests appear to him to be reasonable

A patient who is certified may possess testamentary capacity and one who is not certified may not

Divorce—Insanity can be a reason for divorce and for nullification of a marriage. A petition for divorce may be presented on the ground that the respondent is "incurably of unsound mind and has been continuously under care and treatment for a period of at least five years immediately preceding the presentation of the petition" (Matrimonial Causes Act, 1937). "Under care and treatment" means either certified or a voluntary patient, provided the voluntary treatment follows directly on a period of detention under a certificate

Nullification of a marriage may take place if either party was at the time of the marriage of unsound mind, or a mental defective, or subject to recurrent fits of insanity or epilepsy. The condition of such a decree is that the petitioner was at the time of the marriage ignorant of the facts alleged. The petition has to be filed within a year from the date of marriage. With regard to nullification no details about the type or degree of insanity have as yet been laid down, at any rate, certifiable insanity is not the only necessary condition.

All the necessary forms in connection with the legal aspects of mental illness may be obtained from Messrs Shaw & Sons Ltd, Fetter Lane, E.C.4, or from the institution to which the patient is to be removed.

The Board of Control, the central authority in England, expresses willingness to provide help and information in tackling questions referring to certification, but is not able to pronounce whether a patient should be certified, though it may question the legitimacy of certification subsequently.

DESMOND CURRAN
ERIC GUTTMAN

COMMON DISEASES OF THE SKIN

THE ERYTHEMAS

ERYTHEMA or redness of the skin due to vascular dilatation is the commonest cutaneous reaction to all kinds of stimuli whether external or internal

Erythema may be diffuse or disposed in circumscribed spots or patches, and it may be generalised or of limited distribution. Active erythema is generally bright red in colour and accompanied by more or less tenderness, burning, and itching, the surface temperature is usually raised. The colour of passive erythema is dark red, or even violet, and the temperature of the skin is lowered. Blanching of erythema is produced by pressure. Simple erythema may be complicated by serous exudation, cellular infiltration, and hæmorrhage in the skin with the formation of elevated lesions of various dimensions and colours, sometimes surmounted by bullæ or vesicles.

Classification.—Excluding all due to external causes, the important erythemas may be classified as follows —

A Erythemas of Limited Duration—1 The eruptions of rubella, typhoid fever, typhus, scarlet fever, and the roseola of syphilis, prevariolar erythema, and the erythemas which may accompany puerperal fever and other septicæmias, cholera, and cerebrospinal meningitis. All these have been described elsewhere.

2 Erythematous rashes may follow the administration of an enema or of drugs, especially opium, mercury, quinine, copaiba, phenolphthalein, the iodides and bromides, anti-pyrine, salicylates, digitalis and belladonna. A detailed description of these is beyond the scope of this chapter.

3 Erythema scarlatinoides

4 Recurrent scarlatiniform erythema

5 Erythema nodosum (*vide* p. 76)

6 Erythema multiforme

B Persistent Erythemas—1 Annular centrifugal erythem-

2 Lupus erythematosus 3 Erythema pernio 4 Acrocyanosis 5 Rosacea (*vide* p. 1079)

Erythema Scarlatinoides—The onset is acute and may be accompanied by slight to moderate fever, which may last a few days. The eruption is bright red in colour and closely resembles that of scarlet fever, it may be diffuse or made up of a multitude of minute red points. The distribution is widespread, but part of the surface may be spared. The face may or may not be involved. Exfoliation, which like that of scarlet fever, is usually in the form of large flakes, commences on the third or fourth day, often before the disappearance of the erythema and rapidly involves the whole of the affected surface. The skin returns to its normal condition in about three to four weeks.

The diagnosis from scarlet fever may be difficult in the early stage, but the whole process is of shorter duration.

The eruption may follow the administration of an enema or of certain drugs, notably opium, quinine, and mercury. It may occur in acute rheumatism, tonsillitis, septicæmia, pyæmia, and food poisoning. In many cases, however, no definite cause can be established. There may be recurrences.

Recurrent Scarlatiniform Erythema—This condition, which in spite of its name is not invariably recurrent, also bears some clinical resemblance to scarlet fever. The eruption is preceded for one or two days by slight malaise and fever and sometimes tonsillitis. It appears in the form of diffuse erythematous sheets with moderate pruritus on the trunk or limbs, often predominantly in the large folds, eventually the greater part of the surface may be attacked, the face and extremities are generally involved last. Within a few days and always before the erythema has faded, desquamation usually in the form of large lamellæ begins in one or more places and extends by degrees to cover the whole of the affected surface. Casts of the hands and feet may be shed. The underlying skin is smooth and red and occasionally weeping. The eruption is accompanied by catarrhal redness of the mucous membrane of the nose and pharynx and sometimes by exfoliation of the tongue.

The condition clears up entirely in three or four weeks. There is very little constitutional disturbance. Recurrences may take place at intervals of three to twelve months or longer. The cause is unknown.

The diagnosis may present some difficulty. While there is no point in seeking to distinguish recurrent Scarlatiniform erythema from Erythema scarlatinoides, which is doubtless a benign form of the condition, it is very important to distinguish it from scarlet fever. In the absence of previous attacks the

diagnosis may be doubtful in the first few days, though constitutional symptoms are usually less pronounced than in scarlet fever, after a few days, however, the diagnosis is settled by the early appearance of desquamation, which, unlike that of scarlet fever, begins always during the phase of erythema.

Erythema Multiforme.—A variety of eruptions consisting of raised erythematous lesions of figured outline and of various dimensions are included in this group.

Symptoms—There are four main types of lesion, erythematous, papular, erythematous vesicular, bullous, and nodular. They are accompanied by pruritus and burning, and occur generally in large numbers on the following sites of predilection, the dorsal aspects of the fingers and hands, the forearms and elbows, the face—especially the forehead—the feet, ankles, legs, and knees. Other parts of the body may also be attacked. Lesions also occur frequently on the buccal mucous membrane, especially in recurrent cases, and are occasionally limited to that situation.

The disease, which runs a course of two to four weeks, may begin with slight initial fever, or exceptionally there may be moderate fever lasting a week or longer. Constitutional disturbance is often mild in degree or absent, but there may be pains in the limbs and gastro-intestinal disturbance, sometimes with vomiting, diarrhoea, and passage of blood in the stools, such cases are related to the toxic purpuras. Erythema multiforme occasionally accompanies acute rheumatism.

Recurrences are common, but occur chiefly in the benign cases of the disease.

Erythematous Papular Type—The lesions are raised lenticular papules or patches, exhibiting a central zone which may be violet in colour, or pale from œdema, or hæmorrhagic, surrounded by a peripheral red zone, delicate transitions in tint from one zone to another are often seen.

Erythematous Vesicular Type—The peripheral zone is surrounded by a row of vesicles which may become confluent to form a continuous ring.

Bullous Type—The centre of the lesion is surmounted by a bulla, the peripheral zone may be vesicular.

Nodular Type—The lesions resemble erythema nodosum, but are smaller and usually brighter red in colour. One interesting variety of this type persists if untreated for many months, accompanied by fever throughout, but without severe constitutional symptoms. That it is due to meningococcal septicæmia has been proved by blood culture on many occasions. It is cured almost instantaneously by the administration of sulphapyridine.

The lesions on the mucous membrane begin as erythematous patches or bullæ which quickly become eroded to form rather painful shallow ulcers, often covered by a membrane.

Erythema multiforme is a disease of multiple ætiology. It is an expression of individual sensitivity to toxins derived from various sources. A lesion in the skin itself, such as a whitlow, a persistent patch of impetigo, a burn or pustular ringworm infection are occasional focal causes. Some attacks follow tonsillitis. The recurrent cases have usually no discoverable cause. It is possible that there are really two groups: (1) those in which the eruption is the expression of allergic sensitivity to a demonstrable infection, the mucous membranes are rarely affected and recurrences are uncommon, (2) cases which occur in the complete absence of any other disturbance, and which, like herpes simplex, recur at long or short intervals. The mucous membranes are often attacked, for these there may be a specific, though at present unknown cause.

Treatment—In view of the fact that erythema multiforme may be an expression of a serious condition such as acute rheumatism, it is advisable to regard all initial attacks as potentially serious, and to advise confinement to bed. When past attacks have been unaccompanied by constitutional disturbance, this measure may be unnecessary, but a general examination should always be made, particular note being taken of any elevation of pulse and temperature.

The treatment of recurrent cases is on the whole disappointing but in general it should be directed towards the eradication of possible foci of infection, particular attention being paid to the teeth, tonsils, and sinuses.

Fortunately, the condition does not tend to recur throughout life but disappears in the course of years.

The local treatment is of little importance, and consists of the alleviation of burning and pruritus by the application of soothing liniments or creams, calamine lotion or liniment serve this purpose.

Annular Centrifugal Erythema—This rather uncommon type of erythema consists of raised red patches which enlarge peripherally by a raised cord like border and clear in the centre to form annular, or by confluence with other lesions polycyclic figures. They extend gradually, and in the course of weeks may attain a diameter of several inches. The centre is usually faintly pigmented.

The eruption occurs on any part and there may be several lesions or only one, after several weeks or months they dis-

mately disappear. Recurrences are sometimes seen often at the sites of previous lesions.

The condition is a toxic erythema and is generally thought to be related to erythema multiforme. Eradication of septic teeth tonsils and other foci of infection have in some cases been followed by cure.

Lupus Erythematosus—Symptoms—The lesions of this important disease consist of slightly infiltrated patches of persistent erythema covered with adherent scales. The patches are of oval round polyoyche or irregular outline and have a tendency to clear up in the centre with the production of scarring. The scales may be lamellated or fine or may be present only in the mouths of the hair follicles as horny plugs.

The lamellated scales often show on their under surfaces horny prolongations which project into the follicles. Lesions which have undergone partial healing with atrophy often have a depressed centre and a raised border.

Telangiectases are generally seen both in the atrophied portion and on the actively spreading border. The lesions are the seat of mild burning sensation and occasionally of itching and may be tender to touch. There are four types three of them of limited distribution and usually symmetrical the fourth disseminated they are (1) the fixed type (2) a wandering symmetrical type *Lupus erythematosus migrans* (3) *Hutchinson's chilblain lupus* (4) disseminated *Lupus erythematosus*.

The Fixed Type—The disease occupies especially the bridge of the nose and the malar regions the temples scalp ears and the backs of the hands and fingers especially the terminal phalanges. There may also be lesions on the buccal mucous membrane usually continuous over the lip. One or several patches may be present. The lesions are infiltrated scaly, and extremely persistent healing with marked atrophy and adhesion of the scar to such underlying tissues as the nasal and aurial cartilages. *Lupus erythematosus migrans* begins with bright red congestive patches most often on the cheeks they extend with some rapidity forming eventually by confluence with others more or less extensive areas. They tend also to clear up in the centre sometimes with just detectable atrophy, sometimes without while the peripheral portion remains red turgid and usually covered with fine scales. These cases more unstable than the fixed type of the disease are also more widespread as a rule. It is common to find lesions on the neck and the chest as well as on the hands and forearms.

They link fixed Lupus erythematosus with the disseminated cases and they are sometimes classified as subacute

Hutchinson's Chilblain Lupus — The condition originally described by Jonathan Hutchinson as chilblain lupus is a variety of lupus erythematosus. The lesions resemble chilblains to begin with but become depressed in their centres and scaly, and ultimately heal with atrophy. They occur on both palmar and dorsal aspects of the fingers and are often limited to this situation though lupus erythematosus of the face may sometimes be present. The condition often clears up in summer though scars remain.

Disseminated Lupus Erythematosus — This may occur either as an extension of one of the preceding types or it may be acute and disseminated from the beginning. It is rare.

The onset is acute with fever and often with severe constitutional disturbance. The eruption is in the form of widespread patches and sheets red or violaceous in colour and finely scaly. Scattered bullous lesions may rarely be present. The distribution is more or less universal. These cases may be fatal in the course of several months or they may regress. Relapse after remission even of long duration is however the rule rather than the exception. In fatal cases death is due to bronchopneumonia, pericarditis, pleurisy, septic arthritis and other types of septic infection, occasionally to generalised tuberculosis.

Ætiology — Lupus erythematosus is rare in children and in old age. It occurs chiefly between twenty and fifty years of age. The sites of predilection are those in which the peripheral circulation is most stagnant, the nose, cheeks, ears and fingers. The influence of cold is demonstrably important, also that of sunlight. We do not know how these physical stimuli provoke the changes characteristic of Lupus erythematosus but evidently they alone cannot be responsible.

It has long been believed to be related to tuberculosis, the existence however of tuberculosis elsewhere can rarely be demonstrated and histologically the disease bears not the least resemblance to tuberculosis. However the co-existence of the two conditions is occasionally met with in the chronic types and as already stated a few of the acute cases terminate with generalised tuberculosis. It seems therefore probable that in some at least tuberculosis plays a part.

It is possible also that other infections may be concerned in the process and it has been suggested that because many fatal disseminated cases terminate with some streptococcal complication that some of the chronic cases may be due to latent or focal streptococcal infection.

Treatment—Lupus erythematosus is extremely chronic and intractable, while there is a tendency towards more or less spontaneous resolution, particularly of the superficial variety of the disease attempts to influence it by treatment have in the main proved disappointing. Practical measures consisted in the past of local applications such as carbon dioxide snow or a mixture of phenol and lactic acid. In more recent years some progress in the treatment of the disease has been attained by the use of gold compounds and bismuth. Gold preparations are of particular value in the fixed type but they are not safe in the more unstable types whether localised or disseminated. They are administered by weekly injection a total of about one gramme being given in ten to twelve weekly doses. After an interval of two months or longer a further course may be necessary. The value of this treatment is variable but there is sometimes striking improvement and even complete cure. The dosage usually given is considerably smaller than that employed in the treatment of pulmonary tuberculosis but in spite of this toxic reactions are fairly frequent. An early morbilliform erythema is without immediate serious significance though it may indicate intolerance to the drug and may if the administration of gold is continued be followed by exfoliative dermatitis. The latter condition may however occur without early exhibition of intolerance.

The employment of bismuth by injection in the treatment of lupus erythematosus is quite free from danger but is less effective than gold therapy.

Sulphanilamide in small doses 0.5 gramme three times daily is sometimes of considerable value in the more superficial localised cases and in the wandering type. Localised sepsis *et* in the mouth sinuses or tonsils should receive attention.

Erythema Pernio (Chilblain)—Chilblains are erythematous swellings which occur in cold weather in individuals who suffer from circulatory hypostasis. Children and adolescents are chiefly attacked. The lesions appear first as erythematous patches, but owing to serous exudation and cellular infiltration quickly become transformed into tumefacent swellings. The dorsal aspects of the fingers and toes the ulnar margins of the hands the lateral margin of the feet the heels the ears and nose are chiefly affected. They are accompanied by tenderness burning and itching and are sometimes the seat of superficial vesicles or bullæ. The surface is frequently broken by friction with the production of painful superficial ulcers.

Treatment—The development of chilblains may be prevented to some extent by wearing thick boots warm stockings

and gloves, and especially by active exercise. Calcium by the mouth is a popular remedy but there is no demonstrable disturbance of calcium metabolism and the treatment is probably of no material value. Locally stimulating applications may be used. (For examples vide Therapeutic Section.)

Acrocyanosis—As the name implies, this condition consists of a cyanotic congestive erythema of the extremities. The hands the lower third of the legs and the feet are especially affected. In severe cases the hands are cold blue and moist. On digital pressure the erythema may be made to blanch for as long as half a minute demonstrating the extreme degree of circulatory hypostasis. The condition is most often seen in young adult girls who are nearly always somewhat obese and exhibit on their lower extremities papular follicular lesions resembling those of keratosis pilaris which owing to congestive vascular changes become reddened and especially prominent in cold weather. This change is often spoken of as follicular perniois.

Diffuse blue swellings often appear on the lower thirds of the legs in winter, particularly on the outer aspect. They may be somewhat painful and occasionally become (superficially) ulcerated or the site of huckle. They are not infrequently mistaken for hypodermic tubercles (*Bazins Erythema Induratum*). The frequency of this condition in recent years is attributed in part to the almost universal habit of wearing silk stockings.

The condition disappears partly or completely in summer but recurs each winter for several years. Eventually the cyanotic erythema and swellings diminish to be replaced by a podgy thickening of the extremities which is often observed in middle aged women.

The swellings on the legs may be made to disappear by rest in bed apart from which treatment consists in the wearing of warm stockings and boots and the application of stimulating external applications. Calcium therapy has proved of no value. Relief in severe cases has followed lumbar sympathectomy.

PYOGENIC INFECTIONS OF THE SKIN

The Normal Bacteriology of the Skin—Two micro-organisms have a predilection for the sebaceous follicles the staphylococcus and the acne bacillus. The latter is found in adolescents and adults in the sebaceous and horny material

which can be expressed from the follicles in seborrhœic subjects. Staphylococci are found in single elements in a large proportion of all follicles, while the sweat ducts are generally sterile. In addition to these bacteria, yeast-like organisms are found normally in the skin, especially the pityrosporon, which occurs in the scales of pityriasis capitis, and of seborrhœic dermatitis. Streptococci are not found on healthy skin, though they readily become implanted on damaged skin.

STAPHYLOCOCCAL INFECTIONS

Isolated staphylococci in the mouths of the follicles are harmless, when, however, conditions arise which allow them to multiply, they give rise to a reaction in the form of a follicular pustule. Thus is the primary lesion of all pure staphylococcal eruptions, of which there are six types: (1) simple staphylococcal folliculitis or Bockhardt's impetigo, (2) furunculosis, (3) carbuncle, (4) hidradenitis, (5) sycosis, (6) pemphigus neonatorum.

Bockhardt's Impetigo—The elemental lesion consists of an intra-epidermal pustule almost invariably situated at the mouth of a hair follicle. Its mode of formation is as follows: growth of the organism determines a flow of serum and leucocytes to the colony of microbes situated in the superficial layers of the epidermis. The leucocytes obtain access to the point of multiplication without obvious damage to the deeper layers of the epidermis, but dislocate the more superficial layers and form a little hiconvex intra-epidermal pustule. The reaction results ordinarily in the death of the organism, the pustule slowly dries up into a crust and is finally cast off the surface by regeneration of the epithelium beneath the crust.

Bockhardt's impetigo occurs commonly on the scalp in children generally following an attack of impetigo contagiosa, or it may complicate other conditions such as eczema of the scalp or pediculosis. It is often accompanied by painful suboccipital adenitis. The eruption consists of *hundreds of* yellow pustules, small or large each centred by an emerging hair. It occurs also on other parts.

Furunculosis—The growth of staphylococci is not necessarily confined to the most superficial part of the follicle, but may penetrate to varying depths. When multiplication takes place in the deeper portion of the follicle, one of two reactions may take place: the formation of a perifollicular abscess (furuncular abscess) or sudden massive necrosis of the tissues surrounding the follicle (a furuncle). In either case the deeper

infection is almost always preceded by a small superficial pustule which may have disappeared spontaneously before the more important lesion has attained its full development. In the case of an ordinary boil the staphylococcal colony remains confined to the centre of the process and the death of surrounding tissue is determined by toxins acting at a distance. By degrees the necrosed mass is either separated from the normal tissue by the advent of leucocytes and detached as a core or as a slough or it may be converted into an abscess or sometimes absorbed without breaking down. Of the constitutional factors that predispose to furunculosis very little is known. Many intractable cases appear otherwise to be in good health. Diabetes is however a well known predisposing cause. Occasionally furunculosis is accompanied by a glycosuria which disappears with the cure of the infection. In the majority of cases there is no demonstrable disturbance of sugar metabolism.

Furunculosis frequently relapses over long periods especially in certain places notably the nape of the neck and the large folds. Seborrhoea and hyperhidrosis are predisposing factors.

Carbuncle—The aetiology is similar to that of a boil but the lesions are more extensive. The necrosis of the perifollicular tissue may spread in the subcutaneous tissue to involve several follicles or a carbuncle may be caused by the simultaneous infection of a number of follicles the perifollicular necrosis forming a confluent mass in the skin and subcutaneous tissue. Carbuncles are detached by peripheral suppuration and generally end by separating as a slough.

Hidradenitis—The lesions are intradermal or subcutaneous abscesses found practically only in the axillae and occasionally about the anus. They may complicate seborrhoeic dermatitis of the axillae and hyperhidrosis, and are formed in relation to the sweat glands and not to the hair follicles. They begin as one or more painful dermal or subcutaneous indurations, which may be absorbed or may become soft and finally discharge creamy pus through a thin red epidermis, they are never detached as a core as in furunculosis. They are very prone to recur especially in hot weather.

An attack of furunculosis appears to lower what might be called natural resistance to staphylococcal infection and attempts to raise it by artificial means have not proved very successful. Treatment by vaccines has to some extent been replaced by graduated injection of staphylococcal toxoid or a mixture of toxoid and vaccine (vaccoid) by means of which it is possible to raise to a remarkable degree the capacity of the blood

to inhibit the lysis of rabbit's blood cells by staphylococcal toxin

Among other general remedies must be mentioned sulphathiazole, and sulphapyridine. The striking results of the treatment of a small number of severe staphylococcal infections by the bacteriostatic penicillin, discovered by Fleming suggest the possibility of a future remedy of great value.

Local Treatment—In the stage of the early circumfollicular pustule boils may sometimes be aborted by opening and applying pure carbolic acid or by the galvano cautery, using a fine point, but later than this surgical interference is harmful. Hot Alibour water dressings (*vide p. 1116*) or mercury perchloride dressings, the application of pure ichthyol, or magnesium sulphate mixed with glycerine to make a paste, are all satisfactory forms of local treatment. Similar treatment is suitable for hidradenitis, though the softened abscesses often require opening. Occasionally carbuncles require surgical interference. To prevent recurrences Sabouraud recommends attempting to sterilise the whole skin by adding zinc sulphate to the daily bath in the strength of 1 in 4,000. Mercury and potassium iodide 4 grm. to the bath may also be employed.

Sycosis—In this condition the lesions are follicular pustules of the same anatomical form, for the most part, as the pustule of Boeckhardt's impetigo, though a certain proportion of the follicles are infected more deeply. The infecting organism is always *Staphylococcus aureus*. There are six clinical varieties—

1 Sycosis of the upper lip, which is often secondary to chronic rhinitis and is generally accompanied by chronic blepharitis and often conjunctivitis.

2 Sycosis of the scalp, found generally in children as a complication of a neglected impetigo or chronic eczema. This type is also generally accompanied by ciliary sycosis and sycosis of the eyebrows.

3 Sycosis of the face or chin, often called barbers' rash, this may follow on impetigo contagiosa or occur primarily as folliculitis.

4 Sycosis nuchæ is a fourth variety. The nape of the neck is especially liable both to furunculosis and chronic staphylococcal folliculitis. The latter occurs chiefly in obese subjects with thick necks. Friction of the collar appears to determine the site of the infection in some cases, but in others the folliculitis is above the part which is rubbed in this way, in these intertriginous friction of the redundant skin may be the determining factor. Occasionally the chronic follicular infection is accompanied by fibrous proliferation, the pustules being converted by this process into small hard nodules, or

when confluent into a horizontal irregular fibrous band. When this occurs the condition is spoken of as dermatitis papularis capillitii (Kaposi). The same fibrotic change may accompany pustular acne of the nape of the neck.

5 Lupoid sycosis. In this type the follicles are deeply infected and ultimately destroyed. Central cicatricial alopecia is accompanied by a very gradual centrifugal spread of the infection. The condition is generally found as a single plaque on one cheek or as a more or less widespread area in the scalp.

6 Generalised sycosis. The scalp, eyebrows, eyelashes, beard, axillary, and pubic hair follicles are all affected. These cases are often the sequelæ of chronic eczema of the infective type or sycosis of the scalp in childhood.

Symptoms of Sycosis—The lesions consist either of more or less closely aggregated follicular pustules, situated on a diffusely red background or tuberculous lesions in the positions already described, or of diffuse red areas, often crusted in parts in which isolated follicular pustules may not be seen. They are often associated with fissures at the nasolabial junction and the labial commissures, they differ from simple folliculitis by behaviour rather than by their appearance in being essentially chronic or constantly recurrent. A certain number of the follicles are deeply infected. Some cases of sycosis end after twenty years or more by cicatricial alopecia of the affected part.

Course and Prognosis—Sycois shows little tendency to spontaneous cure, but varies greatly in its response to treatment. The earlier and more localised the case, the greater the probability of complete cure. If the condition has been established for a year or longer, the prognosis is uncertain. Among the more unsatisfactory are the cases which have begun in childhood as an infection of the scalp and eyelashes, in these the beard is often attacked in adult life. Ocular sycois alone, especially if accompanied by chronic nasal catarrh, may also be complicated in adults by intractable sycois of the upper lip and sometimes of the beard generally.

The most refractory form of all is that in which all hairy parts are attacked. In many of these the infection in the scalp, or blepharitis, has been present from childhood.

Treatment—No general treatment can be applied to all cases of sycois, but any defect in the general state of the patient must receive attention. In early cases with debility from such causes as malnutrition, overwork, or alcoholism a long holiday in the open air may be of great value. Vaccines have been employed for many years but have not proved reliable. Staphylococcal toxoid has also failed as a remedy for sycois.

The local treatment is all important. It is first necessary to stop shaving, keeping the hair cut as short as possible with scissors. Crusts must be removed by starch and boric poultices or antiseptic compresses. Alibour water is a suitable preparation for this purpose diluted with 5 to 10 parts of water.

When the crusts have been removed the improvement is often striking but progresses no further. In early cases it is sometimes possible to complete the cure by the application of one of several preparations of which the most valuable is a Compound Quinolor Ointment (Swory and Moore). This is probably the most successful of all local remedies used so far against superficial staphylococcal infections. In the event of intolerance to this preparation, a sulphur paste may be used (*vide p 1117*).

In well established cases it is necessary to epilate the infected areas by X ray. In the majority this proceeding is followed by complete relief from symptoms, but in some a close observation of the affected parts reveals bluish or faint red patches which indicate that the infection persists below the surface. It is impossible to forecast the result of a single epilation in sycosis, in some complete and permanent cure follows, but in others regrowth of the hair is followed either immediately or after a short period of freedom, by relapse.

Sabouraud recommended after the first epilation the continued removal of the hair, including down, by forceps, this should be done by a trained epilator, or in very localised cases, such as those which occur on the upper lip, by the patient.

Chronic Blepharitis—This condition is really sycosis of the eyelashes. The eyelids are red and thickened, the lashes are often spontaneously shed, but this does not lead to cure as in sycosis elsewhere. Conjunctivitis is a common complication. Chronic blepharitis frequently complicates impetigenous eczema of the scalp, and is often found in association with sycosis of the upper lip and with chronic rhinitis following measles.

Pemphigus Neonatorum—This condition, occurring in the first few weeks of life, is not uncommon. The source of infection may be a septic umbilical cord, or the infection may be carried by a midwife from one infant to another. The condition begins as a vesicle which rapidly becomes a large bulla, this is quickly broken, but the lesion continues to spread peripherally, splitting up the horny layer. The lesions may be comparatively small, but frequently large irregular red areas are found, often quite

dry and bounded always by a white collar of detached horny layer. The contents of the vesicles rarely become purulent. Fatal cases have occurred, though the great majority are mild and easily cured.

While pemphigus neonatorum is usually thought to be the counterpart of impetigo contagiosa in adults, the causal organism appears usually to be the *Staphylococcus aureus*.

STREPTOCOCCAL INFECTIONS

While staphylococcal infections affect almost exclusively the hair follicles, streptococci have a predilection for the natural folds of the skin. Thus the commissures of the lips, nasolabial folds, and post auricular grooves are often attacked while other folds such as the intergluteal region and the interdigital spaces, are affected less frequently. The lesion in these situations created by streptococci is an epidermal fissure, which, though not difficult as a rule to cure, is liable to recur on slight provocation. These recurrent fissures form the starting point of repeated attacks of streptococcal infection of the skin as well as occasionally of erysipelas, lymphangitis, or certain cases of eczema. Streptococci may attack any part of the skin, usually by contagion or by extension from an infected mucous surface, or they may infect lesions due to other causes such as scabies, parasitic bites, papular urticaria, or wounds.

There are four chief clinical types of streptococcal infection of the skin, bullous, pityriasic, ulcerative, and fissured.

Bullous Streptococcal Infections of the Skin (Impetigo Contagiosa)—The earliest lesion is an intra-epidermal vesicle filled with sero-fibrinous exudate. This quickly coagulates, ruptures, and forms a yellow crust, at the same time the exudation continues at the circumference of the lesion, splitting up the horny layer. In this way the lesion enlarges, and in so doing rapidly becomes covered by a fresh crust.

Sometimes quite large bullæ are formed before the lesion is broken, particularly upon surfaces where the horny layer is thick, such as the palmar surfaces of the hands and fingers.

Impetigo contagiosa is more common in children than in adults, it is caused by contagion, or it may complicate other conditions, such as papular urticaria, eczema, and particularly the common parasitic infections, scabies and pediculosis-capitis.

Pityriasic Form (Pityriasisform Impetigo)—When impetigo

has been cured irregular scaly patches faintly pink in colour, are often left behind and remain for a variable period on the site of the original lesions. The same scaly lesions may occur spontaneously in children and occasionally in adults, and are almost certainly caused by streptococci. Often such patches are found in the immediate neighbourhood of the nose or mouth, and are obviously caused by nasal discharges or infected saliva. Fissures at the labial commissures and at the nasolabial junction are often seen in such cases.

Ulcerative Form (*Ecthyma*)—This may begin as the ordinary type of impetigo, but under the influence of decreased general or local resistance the skin is more deeply attacked and superficial epidermic infection becomes dermic ulceration.

The lesions are round conical ulcers with a tender red margin. They generally become covered by a thick crust, often purulent in appearance, beneath which pus accumulates. They are found usually on the lower limbs, but are auto-inoculable, and as a rule the fresh lesions, wherever formed, are also ulcerative. Occasionally they give rise to lymphangitis.

Fissured Streptococcal Lesions—These occur in the course of ordinary impetigo, in the post-auricular sulci, the labial commissures, at the nasolabial junction, the webs of the toes, and in any other natural fold of the skin. They occur in these positions also in relation to other conditions, such as chronic rhinitis, septal tonsils, carious teeth, eczema of the scalp extending to the neck and ears, chronic eczema of the interdigital spaces, and eczematoid ringworm of these spaces.

General Treatment of Streptococcal Infections—Impetigo contagiosa usually demands no special general treatment, but an open air life, sunlight, and good food undoubtedly assist greatly some of the more chronic types of infection, such as streptococcal fissures and ecthyma. Ultra-violet light therapy applied to the general surface and locally has also proved of some value. Hebotherapy is the ideal treatment for chronic cases.

Local Measures—*Impetigo Contagiosa*—The essential part of treatment is to keep the lesions clean. Various lotions are used for the purpose of removing the crusts, which should be soaked off gently and not forcibly removed. Hydrogen peroxide 3-5 vols., Albour water (*vide p. 1116*), or $\frac{1}{2}$ per cent. lysol are generally satisfactory. The lesions are treated twice a day, being covered in the intervening period with a weak mercurial ointment or paste, with sulphadiazide powder, $\frac{1}{2}$ to 1 per cent. solution of silver nitrate, or $\frac{1}{2}$ per cent. solution of gentian violet in collamine lotion.

Streptococcal Fissures—A 1 or 2 per cent solution of silver nitrate in spirit of nitrous ether is a proven remedy. The fissures are painted once a day.

Ecthyma—The treatment is the same as for impetigo, but it may be desirable to use hot diluted Alibour water or mercury perchloride $\frac{1}{1000}$ in 1 per cent saline as a fomentation for about an hour twice daily, the lesions being covered in the intervening period with sulphanilamide powder. Rest in bed is necessary when the lower limbs are affected.

Pemphigus Neonatorum—Potassium permanganate baths (1 in 10 000) followed by sulphanilamide powder is usually a satisfactory treatment.

SEBORRHŒA AND ITS COMPLICATIONS

The term seborrhœa means excessive sebaceous secretion. It exists in two forms—

1 Seborrhœa oleosa, in which the sebum is usually mixed with sweat and gives to the skin an oily, shiny appearance.

2 Cystic seborrhœa, in which the sebum, mixed with epithelial detritus, fills up the upper third of the hair follicle in the form of a greasy plug, which can be expressed from the follicle as a filament.

Seborrhœa, however, is not in itself a disease but a manifestation of a common underlying state of the skin which has been named 'kerosis' by Darier. Darier defines this state as consisting of (1) a dirty grey discoloration of the skin, (2) a patulous condition of the follicular orifices, (3) elevation of the follicular collar, (4) slight general thickening of the integument. The condition is present chiefly close to the median line, and is found especially on the nose and cheeks, forehead, scalp, nape of the neck, presternal and interscapular regions, and sometimes on the pubes and sacrum. It is usually associated with more or less hyperhidrosis.

Seborrhœa may become manifest in infancy, either in the form of slight oiliness affecting the face chiefly, or very rarely as comedo acne (grouped comedones of infancy).

After a quiescent interval, during which sebaceous activity diminishes, the secretion becomes abundant during puberty. This may result in acne vulgaris, and at a slightly later period in pityriasis capitis and seborrhœic dermatitis. Later again acne rosacea and rhinophyma may be met with in the subjects of kerosis.

Facial kerosis and seborrhœa may occur in marked degree in young subjects after encephalitis lethargica, in such cases

it is generally associated with Parkinsonian rigidity and excessive salivation

ACNE

The primary lesion of acne is the comedo. This consists of a plug composed of sebum mixed with horny and epithelial detritus which fills the upper third of the follicular canal, the mouth of which is blocked by a black horny cap. Some of the lesions, however, exist in the form of retention cysts, large or small. They are found on the forehead, the nose, nasogenial furrows, the cheeks, chin, neck, ears, back, shoulders, and chest, rarely on the sacrum, buttocks, and extensor aspects of the thighs. In addition to sebum and epithelial debris, the seborrhoeic plug contains myriads of very small bacilli known as acne bacilli. Comedones frequently become pustular owing presumably to infection of retained sebaceous material. *Staphylococcus albus* is grown from these pustules and according to Sabouraud, the acne bacillus may also develop pyogenic activity. There are several clinical varieties of acne.

1 Seborrhoeic plugging of the follicles with few actual comedones but with marked kerosis, a condition which renders the face unsightly by reason of the greasiness and coarseness of the skin.

2 Comedo acne, with large numbers of comedones.

3 Comedo acne, with pustules.

4 Cystic acne. There are comedones and pustules, but particularly a large number of cysts, some of considerable size, occupying the cheeks, the neck, shoulders, chest, and back. These patients are often somewhat obese and physically soft.

5 Acne conglobata. This type is somewhat similar to the above in that the lesions are cystic to begin with, becoming eventually soft abscesses which break down and become covered with rupia like crusts, by confluence and scarring, labyrinths connected by fistulous tracts and fibrous bridges are formed. The shoulders and trunk are chiefly attacked. This type is met with chiefly in middle life.

6 Acne indurata. This name has been given to a variety of acne, the lesions of which consist of somewhat solid papular and nodular elevations which appear to arise beneath the skin and which slowly approach the surface, become red or blue, and sometimes eventually soften and discharge a cheesy material. The lesions are often almost entirely confined to the chin.

and may be unaccompanied by comedones. This variety is found almost exclusively in women. It is usually at its worst immediately before and during the period.

7 Oil acne. Contact with various oils and greases may provoke acne, not only on the face but on parts not normally subject to the condition. Since the beginning of the war the number of these cases has increased enormously, particularly among the operators, male or female, of small capstan lathes. They wear protective rubber aprons but it is not possible to protect the hands and lower part of the legs, which become the seats of innumerable tiny blackheads and acne pustules. Acne, if already present on the face, is aggravated. Oil acne disappears slowly after cessation of contact with oil.

8 Chlorine acne. Halogens provoke in susceptible subjects an acneiform eruption in the places normally subject to acne when taken by the mouth (bromides and iodides), and it is supposed that they do this by reason of their excretion, in part through the sebaceous glands. It seems that these glands may also have an affinity for halogens, for an intense degree of acne occurs frequently in occupations involving external contact with chlorine.

Treatment of Acne—The common comedo acne of puberty and adolescence has a tendency to disappear spontaneously though the most severe degrees of it may persist. It is not usually associated with any defect in general health and the only general treatment of any value consists in maintaining the highest possible degree of physical fitness. Local treatment consists of frequent washing with soap and water, expression of comedones with a comedo expressor, and the application of an exfoliating lotion or paste containing sulphur. As an alternative to exfoliating preparations, ultra violet light may be used. Small repeated applications of superficial X ray, which has a selective depressant action on sebaceous cells, are more effective than any other agent, but should only be applied in urgent cases and with extreme care.

For the other varieties of acne treatment is less satisfactory. Pustules may be opened with a tenotomy knife and emptied; the cysts may be emptied by curetting, their cavities being afterwards touched with pure carbolic acid, or silver nitrate. For these severe acnes also, the application of a strong exfoliating paste for two or three nights in succession is useful. This is repeated at intervals of about a week.

The nodular acne of women is intractable. There is more often than not some defect in general health, the patients are often constipated and easily tired, or their mode of life

is not healthy Vaso motor instability is a factor in some of them At the same time quite a number of them appear to be in good physical condition

All kinds of hormone therapy, including gonadotropic and oestrogenic preparations anterior pituitary extracts, androgen and progestin, have been tried in this and other varieties of acne, but according to the majority of reports, with little success

Staphylococcal toxoid or vaccine have proved valuable occasionally

SEBORRHOEIC ECZEMA

Unn¹ assembled under the name of seborrhoeic eczema a group of eruptions which though differing from one another in some respects had certain characteristics in common there were also transitional forms linking the different members of the group He used the term seborrhoeic because the principal member is found in seborrhoeic subjects and on parts in which sebaceous secretion is most abundant Nevertheless the term is not accepted universally, the French school, particularly, rejecting the role of seborrhoea in their genesis Darier, rejecting seborrhoea as an essential factor but recognising a close relationship with eczema, named them eczematides Confusion has also arisen from a tendency to apply the term seborrhoeic eczema loosely to any eczema occurring in seborrhoeic subjects and to eczema of whatever origin attacking the scalp or the large folds Using the term in its original restricted sense, the members of the group seborrhoeic eczema or eczematides are six in number

They occur most often though not invariably on a seborrhoeic or kerotic background, and dandruff is usually abundant

Seborrhoeic Eczema of the Scalp—Dandruff or pityriasis capitis is probably universal, though more abundant in some, usually seborrhoeic, subjects than in others The scales are not dried sebaceous secretion as they were believed to be at one time, but desquamated horny scales Dandruff gives rise to a certain amount of itching, and it is sometimes associated with inflammation The scalp is generally dry, red, and scaly, but sometimes there is serous oozing The same changes often take place in the eyebrows, and along the margins of the eyelids (seborrhoeic blepharitis), while there is also a tendency for it to spread from the scalp to the ears and on to the neck, dry scaly areas are commonly found on the face Boils, impetigo, and fissures occupying the post auricular folds,

or the corners of the lips or the nares are common complications

The Figurate Type—The sites of election are the centre of the chest and back, it is the most common variety, and it consists of dry scaly patches of petaloid outline. The initial lesion is a dry red papule of about the size of a small pin's head, or a group of papules. By the addition of fresh papules the lesion spreads centrifugally, while those in the centre disappear, leaving a fawn coloured scale, greasy to touch. These petaloid lesions eventually become almost stationary and persist if untreated for months or years.

Subacute Follicular Type—This consists of an acute or subacute follicular papular eruption occurring chiefly on the chest and back. The lesions arise in the course of a few days and do not in the early stage exhibit the figured patches of the dry type, although eventually some such patches may be formed by confluence and involution of the papular lesions. This variety occurs commonly in subjects with hyperhidrosis and in those who work in warm rooms or wear woollen or flannel garments next to the skin. The same factors predispose also to the production of the figured type. The eruption is irritable.

Pityriasisform Type—The lesions are dry, superficial, scaly patches which resemble somewhat the lesions of pityriasis rosea. They have an acute onset and occur quite often on the limbs as well as on the chest, back, and abdomen. This type may be accompanied by vesicular eczema of the palms and soles or of the flexures.

Psoriasisform Type—Seborrhæic dermatitis seldom resembles psoriasis, but occasionally lesions practically indistinguishable from psoriasis are produced. They occur chiefly along the extensor aspects and occasionally on the chest and back. They consist of irregular patches with lamellated scales, which sometimes though not always, spread centrifugally and clear in the centre like the figured patches.

Generalised Seborrhæic Dermatitis—In this rare condition the individual follicular papules coalesce to form large desquamating areas covering a great portion of the skin.

Ætiology—The scales of dandruff are found on staining to contain groups of spores of varying shapes—oval, round dumb bells, or gourds, this organism is a flask like fungus, known as the Bottle bacillus, spore of Mallasez, or pityrosporon, its disposition in the scales is similar to that of microsporon furfur in pityriasis versicolor, and it is widely believed to be the cause of the desquamation. The pityrosporon has been cultivated

and its implantation on the lightly scarified skin has been followed by the appearance of lesions like those of the figurate eczematide. The writer and J M H Macleod obtained similar results by implantation of a monilia grown from the scales of dandruff. Unna thought that dandruff and seborrhoeic eczema might be due to a combination of two organisms, the *Bottle bacillus* and what he called the *morococcus*, now assumed to have been *staphylococcus albus*. On the whole it seems likely that the indolent petaloid variety of members of the group may be due to the growth on the skin of the *pityrosporon*.

It has been held by Ravant that the more acute and wide spread types represent an allergic reaction to infection by yeast like organisms growing for example in intertriginous folds and provoking there the eczema reaction.

The tendency appears to be to look for infection as the direct cause, and a variety of other factors including seborrhoea as predisposing causes. In this latter respect the problem is the same as that presented by eczema in general.

Treatment—The dry figured type of seborrhoeic dermatitis is easily cured by the application of pastes and ointments containing sulphur. For the more acute types sulphur is usually too irritating. Pastes and creams containing solution of tar or ichthyol are generally found valuable. The general management of the more acute cases is similar to that of eczema due to other causes.

SEBORRHOEIC ROSACEA

This condition which consists essentially of congestive erythema over the forehead, nose, cheeks, and chin with occasional extension to the neck and ears, is primarily dependent upon changes in the vessels of the skin. These consist of a persistent dilatation of the capillaries and venules which often leads eventually to the formation of telangiectases. Some degree of constitutional vaso motor instability is commonly present. Rosacea may occur independently of seborrhoea, but when this is present the vascular alterations are frequently complicated by acneiform pustules, and it is for these secondary lesions that patients most often seek advice. Digestive troubles are sometimes present and may accentuate the vascular changes in the skin, chronic gastritis with flatulence and the sensation of fullness after meals are fairly common, and in such cases a meal, a hot drink or alcohol will provoke reflex flushing of the rosaceous areas. The fractional test meal has shown in a small proportion of cases an absent or low free

hydrochloric acid content Rosacea is not uncommon in subjects in whom digestive trouble is entirely lacking Exposure to hard weather conditions may be the sole apparent cause No doubt alcohol is a factor in certain rosaceas but its importance has been exaggerated

Symptoms—In the early stage rosacea consists of attacks of congestion By degrees this becomes permanent and dilated venules develop, particularly on the cheeks and nose In seborrhoeic subjects acneform pustulation and hypertrophy of the sebaceous glands take place, and in extreme degrees may lead to severe disfigurement The nose in particular may be enormously hypertrophied (*rhinophyma*) A small percentage of cases are complicated by corneal ulceration, this is preceded by extension of the rosaceous congestion of the cheeks to the conjunctiva lining the lower eyelids Acne keratitis, as it is called, is sometimes found in purely vascular rosaceas, that is, without seborrhoea or acne

Treatment—This must be directed primarily to the underlying cause Septic teeth must be removed and stimulants prohibited Meals should be simple in quality and small in quantity In those cases which depend upon chronic gastritis, dilute hydrochloric acid taken with, or immediately after, meals is often very valuable Pustular cases often respond satisfactorily to ointments and pastes containing sulphur The dilated venules and capillaries may be destroyed by ignipuncture or electro coagulation Carbon dioxide snow evenly applied for five seconds over the reddened areas will sometimes diminish the persistent erythema Rhinophyma is best treated by plastic operation

ECZEMA

The term eczema is applied not to a single disease of constant aetiology but to a series of inflammatory reactions which succeed one another in stages, and which are caused by widely different pathogenic agents of external or internal origin Clinically, eczema may be found associated with one or several of the following erythema, vesiculation, weeping, crusting, desquamation, lichenification Histologically the changes are constant in type though not in degree In the epidermis they are intercellular oedema with splitting apart

failure of the Malpighian cells to keratinise in the normal way so that the superficial cells retain their nuclei parakeratosis. These imperfectly keratinised cells lack the resistant quality of the normal horny layer and, becoming desiccated as the result of exposure to air, form the desquamated scale of eczema. In the dermis the changes are congestion oedema and more or less perivascular infiltration with small round cells. Leucocytes are not found in the infiltrate in cases uncomplicated by secondary pyogenic infection.

Eczema is brought about by various internal and external agents. The older method of classification was purely descriptive, *e.g.* squamous eczema eczema rubra eczema rimosum. This kind of classification is tending to become replaced by one based on the cause though there still remain many cases in which this is either unknown or only partially known.

It is generally accepted that there is an external factor in very many cases of eczema. In some this external exciting cause is obvious, *e.g.*, in industrial eczema. Sometimes it is no more than exposure to physical stimuli such as sunlight or cold winds. It is important to discover whenever possible the exciting cause whether external or internal and the pre-disposing causes.

External Causes—Traumatic Eczema—This is the result of scratching and may be due simply to pruritus or to some other pruritic disease such as scabies or pediculosis.

Parasitic and Microbic Eczemas—While eczema was originally defined as an essentially amicrobic disease, it is now universally recognised that the eczema reaction can be called forth by various bacteria and fungi. Thus epidermophytosis and other ringworm infections frequently excite an eczematous reaction on the feet and hands. The pityrosporon is responsible for a very important group of eczematous dermatoses known collectively as seborrhœic eczema or seborrhœic dermatitis.

Pyogenic infections of the skin generally of streptococcal and staphylococcal origin frequently give rise to eczema, the genesis of this variety of eczema will be later described under infectious eczematoid dermatitis and impetiginous eczema.

Pyogenic organisms, particularly staphylococci may, on the other hand grow upon eczematous lesions and form secondary impetiginous crusts and pustules.

Chemical Irritants—These are so numerous that it would be useless to attempt to enumerate them. Moreover, their

number is constantly increasing with the growth of industrial science. They may be divided into the following classes —

1. Drugs. Antiseptics such as lysol, formalin, mercuric iodide, iodoform, and others.

2. Substances derived from plants, such as primula obconica, "poison" ivy, chrysanthemums, daffodils, clematis, hops, teak, and many others.

3. Chemical substances used in all kinds of occupations, such as bichromate of potassium and ammonium used by engravers, tanners, furniture polishers, and others, aniline dyes, especially paraphenylene diamine, used in the process of dyeing fur, metolquinal and sodium hyposulphite by photographers, soda by housewives, lime and cement by builders, sugar by sweetmakers, dough and flour by bakers, turpentine by painters. These are some of the common ones, but there are many others.

Predisposing Causes of Eczema.—Certain constitutional conditions predispose to eczema of occupational origin. Of these the most important is hyperhidrosis, ichthyosis is also a predisposing cause. Gout and eczema are rather rarely associated in spite of the time honoured belief to the contrary. Diabetes is occasionally complicated by eczema, but the eruption nearly always begins on the genitals and is caused by the irritant action of sugar laden urine.

A very important group of cases are due to an inherent constitutional defect in the individual now often termed atopy (Coca), which generally runs in families and of which the manifestations are eczema, asthma, hay fever, and urticaria. The disease is often termed Prurigo of Besnier, the eczema asthma complex, or atopic eczema (*vide p 1093*).

Symptoms of Eczema.—In an acute outbreak of eczema or in an exacerbation of a chronic eczema there is always in addition to more or less severe pruritus, which is a constant symptom, some degree of malaise and occasionally slight fever. The eruption itself is almost always polymorphic, some of the lesions exhibiting vesiculation, some crusting or weeping, or, in the healing stage, desquamation. Different stages of the reaction may be found in different parts of the same patch of eczema. An important objective symptom is oedema of the true skin. This gives to the lesions a somewhat firm consistency. The attack begins with a patch of erythema which quickly becomes strewed with epidermal vesicles, which approach the surface, rupture, and discharge clear serum. The serum dries and forms crusts. If these be removed, tiny superficial pits are observed, which continue to discharge

serum The weeping stage usually lasts several days and is followed by a squamous stage The desquamation may be slight and furfuraceous or abundant On the palms and soles desquamation is usually specially abundant, or there may be marked thickening of the horny layer The vesicular stage may be lacking from the first, which means that the primary vesicle has been too small to be seen with the naked eye A patch of eczema may resolve completely or it may persist Often chronicity is the result of persistent scratching in the course of several weeks an infiltrated patch is produced with marked epidermal thickening In such a patch the normal furrows of the skin become accentuated This stage is known as lichenification

During the weeping stage the serum often becomes infected with pyogenic organisms This secondary infection or impetiginisation can give rise to folliculitis, boils abscesses adenitis lymphangitis, sycosis, and blepharitis

Distribution and Configuration.—Eczema has a predilection for exposed surfaces and for the large articular and other folds, but no part of the surface is exempt There are, however, certain well-defined varieties which merit separate description

Eczema is usually disposed in irregular patches of variable size, but sometimes it occurs in coin shaped plaques, often found on the forearms, backs of the hands, and thighs, though not infrequently on other parts of the body This type has received the descriptive name of *nummular eczema* or *papulo vesicular eczema* The lesions begin usually as a single large vesicle situated on a papular base Other similar vesicles quickly appear in the immediate neighbourhood In the course of days a confluent, rather firm plaque is formed With rupture of the vesicles a superficial confluent crust forms The eruption comes out in crops and is frequently associated with patches of the ordinary irregular type Nummular eczema is recognised as occurring commonly in connection with either a long standing chronic patch of eczema, e.g., varicose eczema, or with some local septic lesion of the skin, e.g., a whitlow, boil, discharging sinus, or infected wound In many cases, however, no primary sensitising focus can be found in the skin, and it is probable that some cases are of internal toxic origin.

Dysidrosis or Cheiopompholyx—The eruption which was first described by Tilbury Fox, begins in the form of epidermal vesicles upon the palms and soles and lateral aspects of the fingers and toes Owing to the thickness of the horny layer in

these regions, the vesicles seldom rupture, and feel like lead shot in the skin. Occasionally they rupture, particularly on the fingers, but as a rule they are absorbed in the course of three to four weeks and give place to desquamation. Generally this is very abundant, and regeneration of the horny epidermis takes place slowly in the course of three or four weeks. During the eruptive stage itching is a pronounced symptom. Dysidrosis occurs almost exclusively in subjects with hyperhidrosis of the palms and soles, it is a recurrent disease and is comparatively common in the warmer months. In some subjects, however, it recurs at more or less regular intervals irrespective of temperature. Tilbury Fox believed that dysidrosis was caused by an acute dilatation of the sweat ducts, but histological studies have shown that the primary lesion is a typical eczematous vesicle. It is evident, however, that the disease is related to a disturbance of the sweat apparatus, the precise nature of which is at present undetermined. True dysidrosis has to be differentiated from a number of eruptions of different aetiology with which it is objectively identical. Thus there is a type of dysidrosiform fungus infection of the soles and palms caused by the epidermophyton interdigitale and also a type associated with seborrhoeic eczema. Another type is caused by external irritants, a dysidrosiform form of eruption being quite commonly of occupational origin, or a dysidrosiform type of eczema may be found associated with other forms of eczema elsewhere. The differential diagnosis, particularly of a first attack, is often extremely difficult, and it is essential to exclude fungus infection by microscopical examination of the roofs of the vesicles, as well as to exclude a seborrhoeic or occupational cause.

Keratotic Eczema of the Palms and Soles—This type occurs most commonly in elderly subjects. It is accompanied often by deep fissure in the natural folds.

Hypostatic and Varicose Eczema—This type, due to vascular stasis, is often found over the malleoli, about the ankles, feet, and on the legs, chiefly in heavy subjects with or without varicose veins. An area of vesicular, squamous or lichenified eczema may be found, which frequently becomes impetiginous. Similar areas of chronic eczema are found on the legs in elderly subjects in the absence of varicosities, and are to be attributed both to hypostasis and senile devitalisation of the skin. In some cases the whole of the leg may be involved.

Impetiginous Eczema of Children—In neglected cases of impetigo of the scalp, and the ears in particular, chronic eczema frequently supervenes. The skin becomes sensitised to the

infecting organisms or to the products of tissue disintegration, and a simple pyodermitis becomes transformed into a pyogenic eczema. In acute cases the scalp, ears, and post auricular folds pour with serum. This is followed by a crusted stage, and finally by a stage with constant desquamation. Sometimes the hair is suddenly shed, either partially or completely during an attack, and following this event recovery is usually rapid. Relapses may take place at intervals throughout life.

Seborrhæic Eczema—This is described elsewhere (*vide* p. 1077).

Infectious Eczematoid Dermatitis—This name was applied by Engman to eczema of more or less generalised distribution which arises in connection with pyogenic infection of the skin. Its pathogenesis is no doubt similar to that of impetiginous eczema in children. The lesions are often of the papulo-vesicular type and may occur in nummular patches.

Eczema caused by External Irritants—Some of the chemical substances capable of causing eczema have been already mentioned. The lesions do not differ from those of eczema due to other causes, and are found on the parts exposed to the irritant, usually the forearms, wrists and hands, particularly the interdigital spaces and lateral aspects of the fingers, and sometimes the face and neck. The eruption may be vesicular or squamous fissured, secondarily impetiginised in parts or lichenified, and disposed more or less uniformly in the areas affected, or in nummular or irregular patches. There is a tendency to spread beyond the regions primarily affected, *e.g.*, to the face and neck and the flexures. The extension is thought to be due to some sensitising substance derived from the initial focus.

The substances commonly responsible for occupational eczema are irritating only to susceptible individuals. Subjects with hyperhidrosis or ichthyosis especially the former are more liable to become sensitive than are those with normal skins. Susceptibility is generally acquired after prolonged contact with the irritant substance, or expressed in another way, the skin after sustaining for years the impact of some damaging substance eventually breaks down. This often occurs after many years and at an age when the natural resistance of the skin is diminishing. Far more rarely sensitivity is exhibited almost immediately (idiosyncrasy). In either case the disease is cured either rapidly or sometimes particularly in the former group with considerable difficulty after cessation of contact with the irritant substance. Eventually the skin may appear to be normal but re-exposure invariably excites a recurrence.

Moreover, the individual has often acquired a tendency to develop eczema on exposure to chemical irritants other than those which he has previously handled

Infantile Eczema—There are three well-defined types of infantile eczema (1) primary eczema of the face, (2) eczema of the scalp of infective origin, (3) eczema derived from naphin erythema

Primary Eczema of the Face (Atopic Eczema)—This occurs at any period from the second month onwards, and usually affects the forehead and cheeks, but spares the nose and chin. Other parts of the body are also often affected. The eczema may take the form of a vesicular and weeping eruption in fat children, but is often dry and scaly in marasmic infants. The scalp is usually spared at first, but is generally involved eventually by direct extension of the process. The condition may clear up quickly, but is more often intractable. It may disappear at the end of the teething period. When it persists, it tends largely to leave the face and to appear predominantly in the flexures in the form of lichenification. In this phase of the condition, which is known usually as Prurigo of Besnier, the lesions are determined almost entirely by scratching. It may persist with remissions and exacerbations to puberty or into adult life, and even after disappearance in infancy may recur in later years. About 30 per cent of the cases develop asthma or chronic bronchitis, usually from three years of age onwards; about 20 per cent have ichthyosis. When the disease occurs in older children or in adults, the constant friction and consequent thickening of the skin of the face produces a characteristic rigid aspect. Accentuation of the normal furrows about the mouth is often striking in these older subjects, and this, combined with an earthy complexion, which is equally characteristic, is a safe guide to the correct diagnosis. These patients are often sensitive to one or more allergens, such as foodstuffs, animal emanations, and pollens, but although these may give rise to such temporary symptoms as sickness, urticaria, swelling of the mouth or hay fever, they are evidently not responsible for the constant itching and prurigo. In infancy absorption of fat is almost always imperfect.

Infantile Eczema of the Scalp—This type, which begins at about the same period as the preceding, appears usually to originate from pityriasis of the scalp. The scales are sometimes found on examination to be infected with the pityrosporon. In some cases it is possible that the infection may be transmitted from the parents. The eczema may be vesicular, crusted, or squamous, and tends to extend to the post auricular grooves,

the neck, and the face, and sometimes to other parts. It is more amenable to treatment than the preceding type.

Intertriginous Eczema—This usually occurs primarily in the naphin area as a diffuso erythema affecting the convex surfaces of the buttocks and thighs, and is due to the irritating action of the urine, which is nearly always ammoniacal. This change is caused by the action of a bacillus found in the feces which has the property of converting urea into ammonia. Although a simple erythema to begin with the condition tends to spread into the inguino-crural and intergluteal folds and to become eczematous. The eczema may become widespread.

TREATMENT OF ECZEMA

The subject is too large to be dealt with here in any but the most summary fashion. The treatment of eczema is greatly facilitated if the cause can be accurately ascertained and eliminated. In certain cases rapid cures are often achieved by the successful treatment of a focus of origin such as a patch of lichenification, a varicose ulcer, or any chronic septic lesion in the skin, in others by the discovery of an unrecognised external factor, such as a plant to which the individual is sensitive, or by cessation of work in eczema of occupational origin. Enough has already been said regarding the causes of the various types of eczema to indicate the manner in which a given case should be investigated. Of equal importance is the alleviation of symptoms by local and general measures.

Local Treatment—There are certain principles to be observed but the treatment must be elastic varying according to the stage of the disease. Its object which is to restore a damaged epidermis to its normal state, and particularly to assure that the horny layer is fully re-established, is best attained by careful protective measures.

In the acute erythematous and vesicular stages, in order to facilitate evaporation and drainage of serum and to cool an inflamed surface, it is advisable to use simple watery lotions, watery pastes, or oily liniments containing no antiseptic. Calamine lotion, lead lotion, or calamine liniment may be used for this purpose.

In impetiginous and crusted eczemas accumulated crusts must be removed, this is often best accomplished by starch and boracic poultices, or it may be advisable to soak off impetiginous crusts with a weak antiseptic, *e.g.*, solution of potassium permanganate 1 in 4 000, or silver nitrate 1 or 2 per cent in water, before applying any other remedy.

In the natural course of events the weeping stage of eczema is succeeded by desquamation (parakeratosis). At this stage protective creams and pastes which formerly would have been badly tolerated are indicated. These replace in part the fat which is lacking in the parakeratotic cells.

When, as a result of repeated scratching, lichenified and indolent infiltrated patches of eczema are produced, it is usually advisable to add one of the reducing agents such as ichthyol tar, or lenigallol in varying proportions to a paste or cream (*vide p. 1118*). To such patches X rays applied in fractional doses are often of the greatest value.

General Measures—In the acute stage of eczema there is no general measure more valuable than complete mental and physical rest. The digestion and excretory functions must receive careful attention.

There are no hard and fast rules regarding diet in eczema, overfed obese subjects benefit from a weight reducing regime, equally malnutrition when present in eczema should receive appropriate dietetic treatment. Alcohol should be forbidden. In atopic eczema the diet should be free from allergens to which the patient is found to be sensitive.

Treatment by Internal Remedies—The eczematous reaction results from numerous causes, and there is no single remedy capable of universal application in its treatment. Drugs are of value only in exceptional cases. The intravenous injection of sodium thiosulphate $\frac{1}{2}$ to 1 gm., in 10 per cent solution is used extensively for dermatitis due to gold or the organic arsenical preparations. Though also used in the treatment of widespread eczema, this treatment is of doubtful value. The daily intravenous injection of a 10 per cent solution of sodium or strontium bromide in physiological saline is of value in reducing œdema and weeping in cases of widespread eczema but not in localised cases. Autohæmotherapy, the injection of 10 to 15 c.c. of the patient's own blood into a muscle, about every five days meets with success in a number of widespread but not localised eczemas. Arsenic has been almost given up but it is helpful when given for short periods in certain cases notably the nummular papule vesicular type.

ERYTHEMATO SQUAMOUS DERMATOSES

A number of dermatoses consist essentially of dry scaly erythematous spots and patches. Among these are certain cases of ringworm infection, lupus erythematosus, the type

of streptococcal infection known as pityriasisform impetigo, some irritant and toxic eczemas, and seborrhoeic eczema. Under the heading of erythematous squamous dermatoses are also included three unrelated dermatoses of unknown cause, namely Pityriasis rosea, Psoriasis, and the Parapsoriasis. For a description of the last named the reader is referred to works on dermatology.

PITYRIASIS ROSEA

The eruption consists of two types of lesion —

1 Pink squamous macules, irregular in shape and varying in size from a pin's head to a lentil or larger.

2 Circumscribed oval macules, generally described as medallions. The periphery of the lesion is often pink and slightly raised, while the centre is fawn coloured. The scales are often arranged as a collarette just inside the peripheral pink zone. Moderate pruritus is usually present.

Usually the generalised eruption is preceded for several days by a single medallion larger than those which are to follow. This is called the *herald patch*. The disease runs a self limited course and clears up within two months. Slight enlargement of the lymphatic glands may be present, and it is extremely probable that the condition is caused by an infective agent. Recurrences are very rare.

Treatment—Pityriasis rosea is better left untreated. To allay irritation, when present, phenolated calamine lotion may be used. Ointments are badly tolerated.

PSORIASIS

This important disease is one of the commonest in dermatology and one of the most intractable. It occurs in the form of red scaly spots, patches, and even sheets of the greatest possible variety of shapes and sizes. The terms guttate, nummular, discoid, gyrate, circinate, rupoid, and others are descriptive names applied to the numerous varieties of the disease. The characteristic lesion consists of a red patch or spot covered with dry lamellated scales, which are heaped up on one another to a variable degree, and when gently scraped with a curette exhibit a silvery lustre. Complete removal of the scaly portion of the lesion exposes a red glistening surface upon which soon appear fine bleeding points. Psoriasis appears particularly upon prominences and on other parts which are naturally subjected to trauma, thus the scalp is rarely spared, and the elbows and knees are almost invariably affected. The

extensor surfaces of the limbs suffer more frequently than the flexor surfaces, but no part of the body is exempt. The exposed surfaces are less often attacked than the covered parts. The eruption may be extremely profuse or limited to a few spots. The scalp may be affected alone, or the nails alone, or the palms and soles, or the elbows and knees. There is a strong tendency to symmetry and uniformity of lesion.

Psoriasis of the Scalp—This is frequently mistaken for seborrhœic dermatitis. On the scalp psoriasis generally occurs in the form of well circumscribed patches with marked heaping up of scales on the surface and with intervening normal areas of scalp, while seborrhœic dermatitis is usually distributed over the whole scalp, and the scales are less lamellated.

Intertrigenous Psoriasis—This type affects particularly the articular and other folds, and is usually disposed in large flat patches covered with crusts rather than scales, often fissured and sometimes weeping. This variety, which closely resembles eczema, is rather frequent in elderly and obese subjects, the deep red colour and sharp outline of the plaques are sufficient to distinguish them from eczema.

Universal Psoriasis—Psoriasis may be disposed in extensive red sheets constantly desquamating and covering almost the entire surface.

Psoriasis of the Nails—This may exist alone. The nails are pitted, longitudinally or transversely striated, and thickened to a varying degree. They may be partially separated from their beds.

Psoriasis of the Palms and Soles—This exists usually in company with psoriasis elsewhere either in the form of well circumscribed hyperkeratotic plaques or of a confluent area involving the whole or the greater part of the palmar surface. It is not usually irritable.

Pustular Psoriasis—This extremely intractable condition occurs almost invariably on the palms and soles, and consists of red scaly areas of variable dimensions and shape studded with intraepidermal yellow pustules of about the size of a small pin's head. The pustules dry up in the course of a few days and are at first replaced by small yellowish brown spots consisting of dead epithelium and leucocytes, which eventually separate to leave shallow pits bounded by a detached horny collar. Fresh pustules continue to appear both in the affected areas and in the neighbouring healthy skin.

Arthropathic Psoriasis—Psoriasis is commonly associated with rheumatism of all degrees, ranging from slight stiffness in one or two joints to severe rheumatoid arthritis, the psoriasis in such cases often extensive and inveterate.

Evolution and Prognosis.—Psoriasis begins usually as an acute attack affecting the limbs and trunk. The lesions are usually, though not invariably, of the guttate type in the first attack. Thereafter, one attack succeeds another, with intervals of comparative, though seldom complete, freedom. While exacerbations and remissions are the general rule, a certain number of patients have only a few lesions, often on the points of predilection, which last for years. Under treatment psoriasis may sometimes be made to clear up entirely. With the disappearance of the spots, depigmented patches are generally left, particularly after treatment with chrysarobin, sometimes, however, pigmented patches remain for months. No case can be regarded as permanently cured.

Ætiology.—Psoriasis may occur at any age in both sexes, in all races, and in all countries. First attacks are most common at school age and adolescence, but are not very uncommon in old age. Though the precise causes are quite unknown certain ætiological factors are established, of which the most important is heredity. The exciting factors are variable or apparently non-existent in many cases. Pregnancy is an exciting cause in some cases, while others are only free from psoriasis during pregnancy and lactation. Trauma is a well recognised cause, and the occurrence of psoriasis upon prominences is an expression of this factor. The first attack of an acute guttate psoriasis is very often preceded by tonsillitis. On the other hand, psoriasis may clear up during a severe febrile illness. The seasons and climate have an influence on its production, it is said to be uncommon in the tropics. In the present state of knowledge perhaps the most rational view is that there is an inherent fault in the skin of some individuals who have an innate predisposition, often obviously inherited, to react in the form of psoriasis to various stimuli, internal and external.

Treatment.—This consists mainly in the application of various remedies which have proved capable of curing the condition temporarily. The first stage of local treatment consists in the removal of the scales. This is done by softening for several days with saleylated olive oil or with a simple ointment containing saleylic acid, and is further facilitated by the daily use of soap and warm water, using a nail brush. A preparation containing one or other of the reducing agents is then used. Solution of coal tar, crude tar, oil of cade, and chrysarobin are those most frequently employed, of which the last is the most effective, though dirty and sometimes badly tolerated. Dithranol, a more active but cleaner derivative of

chrysarobin, is now often used. X rays are often used to clear up obstinate patches but although a clean method and usually successful, this form of treatment is unsatisfactory on account of the risk of damaging the skin. Moreover, the use of X rays often renders subsequent attacks more intractable. The mercury vapour and carbon arc lamps have been used successfully in some cases as local treatment, especially in combination with crude coal tar.

Numerous internal remedies have been tried, of which the best known is arsenic, which in full doses appears to be of some real value in acute cases of the guttate type, and other varieties in which the acute stage has come to an end, but sometimes it is useless and even harmful. Arsenic is usually badly tolerated when psoriasis is disposed in sheets or in irritable plaques, and in universal psoriasis. Neosalvarsan and its derivatives have been extensively tried and have proved successful in a few cases. Salicin, salol, and sodium salicylate have been given and have proved of value occasionally. Protein shock treatment in the form of intramuscular injections of sterile milk, 3 to 5 c c every fourth or fifth day, have been used with success in some cases.

In the acute stage treatment in bed is advisable for three to four weeks, for acute psoriasis improves rapidly with complete rest. Local treatment is begun by the softening and removal of scales in the manner already described. This is followed by application twice daily of one or other of the preparations already mentioned such as chrysarobin ointment (see Therapeutic Section). If chrysarobin is used, a weak preparation 2 to 3 per cent, is first employed. The strength is increased by degrees up to 12 to 14 per cent. In a successful case the lesions clear up within three to four weeks by this method, and a depigmented patch of skin surrounded by an inflammatory halo is left. Treatment is continued four to five days beyond this point. Chrysarobin stains light hair violet, and is therefore sometimes unsuitable for the scalp. An ointment containing tar or oil of cade may be used instead. These preparations are weaker than chrysarobin, but can be continued for a much longer period. One or other of the internal remedies already mentioned may be used, but correctly applied local treatment will often alone effect the desired result.

ALLERGY AND DISEASES OF THE SKIN

The term "allergy" (altered reaction) was coined by Von Pirquet to denote the alteration in degree of sensitivity

of the skin to Koch's old tuberculin which he observed during the various phases of tuberculosis. It was heightened during some phases and diminished or absent in others such as advanced pulmonary tuberculosis. From that time the term has been employed to cover an ever increasing field including some conditions which appear to be closely related to anaphylaxis.

At the present time the term is generally held to imply reactivity to an agent of any kind which at some previous time provoked no reaction at all or a slighter one.

Coca classifies the manifestations of allergy as follows —

- 1 Serum sickness 2 Atopy 3 Drug allergy 4 Bacterial allergy
- 5 Dermatitis—sensitivity to external irritants

Coca coined the term 'atopy' to denote a special liability to develop sensitivities of various kinds that often runs in families and under atopic diseases he includes atopic eczema, asthma, hay fever, and urticaria. Among the manifestations of the atopic state there is a strong tendency to develop sensitivity to various food stuffs, animal emanations, pollens and even house dust.

The presence of such hypersensitivity can be demonstrated by the passive transfer test (Prausnitz-Kustner reaction). A drop of the serum of a sensitive subject is injected intradermally into a normal subject. Within about half an hour the site of injection will exhibit sensitivity to an extract of the substance to which the patient is sensitive when applied as a skin test, by scratch test or intradermal injection, or to a food if taken by mouth. This reaction becomes more pronounced after twenty-four hours and the sensitised patch of skin remains sensitive for several weeks.

Sensitivity to foods is manifested either by alimentary intolerance, sickness or diarrhoea, by swelling of the lips or face, or by generalised erythema or urticaria. It has been too readily assumed that infantile eczema is the result of hyper-sensitivity to food. This condition appears and persists in infants on a pure milk diet in whom sensitivity to milk is absent. Most of them give a positive reaction to egg even when no egg has been given at any time, and the strict avoidance of egg does not usually terminate the eczema. The exact mechanism of this type of atopy has not yet been clearly demonstrated.

URTICARIA

Symptoms—This common condition is characterised by the development of transient wheals. The first objective symptom

a patch of erythema, which is quickly followed in a typical case by formation of a central wheal surrounded by a peripheral erythematous zone. The lesions may be round, oval, or polycyclic outline; they are of all sizes, and may occur on any part of the body. They are invariably accompanied by severe itching, which is greatest in the erythematous or even the pre-erythematous stage of the lesion. The swelling slowly subsides, to disappear as a rule within a few hours. An acute attack may be accompanied by transient slight fever.

Varieties.—Modifications in the objective features of urticaria have given rise to special names. In giant urticaria or angioneurotic œdema the lesions are large œdematous swellings involving the subcutaneous tissue, and often the mucous membranes, particularly of the mouth, and occasionally of the pharynx and larynx. The condition may or may not be accompanied by the common type of wheal.

Bullous urticaria, in which some of the lesions consist of large bullæ, is rare. Extravasation of blood into the lesions has given rise to the name *hæmorrhagic urticaria*; this also is uncommon.

Urticaria Due to Heat.—This not very common variety has been studied by R. T. Grant and Bruce Pearson. It appears only as the result of heat or emotion. Strenuous exercise, hot baths, or emotional excitement are followed by a generalised crop of small urticarial spots which persist for a few hours and do not re-appear until the patient is again subjected to the same conditions. A severe attack is followed by a short refractory period during which exercise may be taken with impunity. Most of the subjects have been young women.

Urticaria Due to Cold.—After exposure to cold air or cold water the part of the skin so exposed becomes the site of a urticarial eruption or patchy erythema similar to that caused by heat. Occasionally the two conditions are found in the same subject.

Course and Prognosis.—The majority of urticarias are due to the ingestion of some food stuff to which the individual is sensitive or to partially decomposed food. These cases seldom persist for more than a few weeks. There are, however, a great number of chronic urticarias in which it appears to be impossible to incriminate any food stuff as the cause, and these may persist for many months or even years with occasional remissions. Angioneurotic œdema or giant urticaria is a particularly persistent type.

Ætiology and Pathogenesis.—The urticarial reaction may be called forth by numerous causes of external or internal origin. The sting of a nettle, and the bites of mosquitoes,

fleas, bugs, and other insects arouse urticarial reactions of varying intensity according to individual susceptibility. Of internal causes the most important is the ingestion of a protein to which the individual is susceptible. Fish, egg, pork, decomposing food of any kind, and strawberries are the most frequent examples. Hydatids and intestinal worms are occasional causes.

Urticaria may also be caused by toxic products developed in the body. Thus it may occur in pregnancy and in the course of disease.

The researches of Lewis and Grant have thrown light on the mode of production of urticaria. It has been shown that a lesion identical with an urticarial wheal may be produced by pricking into the skin a drop of a solution of histamine of 1 in 20 000 dilution. The reaction so produced is threefold in nature: first, capillary dilatation due to the direct action of histamine on the capillary wall; then an areolar flush due to reflex dilatation of arterioles round the puncture; then increased permeability of the capillary wall leading to oedema and wheal formation.

The mechanism of urticaria caused by sensitivity to food has been shown to be related to anaphylaxis by the study of the passive transfer reaction. It is assumed that in the affected tissues there are fixed antibodies and that the interaction of such antibodies with the food stuff gives rise to an explosive reaction, perhaps with a liberation of histamine. In urticaria due to heat the mechanism has been shown also to be due to the liberation of histamine. This type can be inhibited in an area such as an upper limb by blocking the cutaneous nerves. It can also be brought on by the administration of Doryl (acetylcholine). R. T. Grant and Bruce Pearson have shown that first the parasympathetic nerves are stimulated by heat with the liberation of acetylcholine and secondarily histamine, presumably in these subjects in excess. Exercise may produce a histamine effect of such severity as to give rise to marked pallor, a rapid pulse and a fall in blood pressure. Urticaria due to cold can be passively transferred to a normal subject by the intradermal injection of the serum of a cold sensitive subject. The site of the skin so treated if immediately exposed to cold, *eg.* from a cold water tap and afterwards warmed, develops a wheal. It is supposed that a dermolysin exists in the blood of such subjects which, when the skin is exposed to cold, becomes fixed to the cutaneous cells lysing them on re-warming. This type of urticaria is sometimes found in subjects with paroxysmal hemoglobinuria.

Treatment of Urticaria.—Success in the treatment of urticaria depends chiefly upon elimination or avoidance of the cause. When the cause is definitely known to be a food such as shell fish egg or strawberries the prognosis is generally good, although an attack may be prolonged for a few weeks.

Of treatment by drugs calcium lactate by mouth or calcium chloride injected intramuscularly have been used extensively but with disappointing results. Subcutaneous injections of 5 to 10 minims of adrenalina hydrochloride have been used successfully for the immediate relief of symptoms and are valuable in angio neurotic oedema but the effect is transient.

Chronic Urticaria—A small number of these cases have cleared up after the eradication of septic foci of various kinds but in the majority of cases the cause is quite obscure. There is sometimes an atopic family history but this is very often lacking. The patients have often been sensitive to insect bites and may be said to have a constitutional tendency to urticaria. Perhaps some accidental cause provokes the urticarial reaction in the first place and this may persist in the complete absence of a demonstrable cause. Nervous reactions seem to play a part in this type quite frequently and many of the patients are temperamentally unstable. These cases vary enormously in duration. In a certain proportion the intramuscular injection every 3rd or 4th day of 10 c c of the patient's own blood has been followed by relief but in cases of long duration this remedy usually fails. For these complete physical and mental rest has proved about the most effective remedy.

Treatment of urticaria by local measures is of secondary importance. Lead or calamine lotion with the addition of phenol 10 gr or liquor picis carbonis 1 drachm to the ounce of lotion serve to diminish pruritus.

PAPULAR URTICALIA

This common condition occurs chiefly in infants and young children. The lesions consist of firm papules surrounded by a halo of erythema. Often the central papule is surmounted or even replaced by a vesicle or bulla. The eruption may occur on any part and may be mild or of extreme severity. It is always markedly pruritic. An attack normally lasts about three weeks but may be prolonged for months. The condition usually dies out at the age of four or five years but may last until puberty or later. In persistent cases the lesions become aggregated on parts naturally subjected to trauma and

particularly along the extensor aspects of the limbs and on the buttocks. There is in such cases a close resemblance to Hebra's prurigo, which disease is believed by some to be a severe form of papular urticaria.

Ætiology.—In the majority of cases of papular urticaria no cause can be discovered, though rarely it may be recognised as a definite article of diet. Attacks occasionally occur during the eruption of a tooth. Intestinal worms are held to be responsible for some cases. R. Hallam observed that the eruption invariably cleared up on admission to hospital and that a relapse often followed the return of the patients to their homes. His careful investigations suggest that the cause may often be connected with sleeping conditions at home.

Treatment.—This consists in the avoidance of the cause when known, though usually partial alleviation of symptoms is all that can be achieved. Moderate restriction of carbohydrates, particularly in the form of sweets, together with mild laxative treatment is often prescribed but in general an attack cannot be shortened by these means. A change of locality will often bring about a cure in chronic cases and particularly a period of treatment in a hospital ward. For local treatment an anti pruritic ointment containing phenol may be used. Cotton or silk garments should be worn next the skin. Secondly infected lesions should be treated by local antiseptic remedies.

DISEASES DUE TO FUNGI

The group of diseases caused by fungi is one of the most important in dermatology. Although many types of fungi occur in nature, only a few are parasitic on man, and these belong to a class which from their extremely simple mode of existence are known as the fungi imperfecti. These consist of round or oval spores which are concerned with reproduction, and protoplasmic filaments known as hyphæ, a mass of hyphæ is termed mycelium.

There are three important groups of pathogenic fungi —

- 1 The ringworm fungi
- 2 A group of fungi resembling yeasts of which the thrush fungus, *ospora albicans monilia* Pinoyi, and the pityrosporon are examples
- 3 Nocardiae or streptothrices, of which actinomyces (*vide* p. 86) is the most important member

THE RINGWORM INFECTIONS

The ringworm fungi grow on the skin and produce five types of reaction —

1 Some attack chiefly the horny layer, with the production of scaly lesions, also they attack the hair, which is a specialised portion of this layer

2 The epidermis may be attacked with the production of vesicular lesions

3 Some of the ringworm fungi excite a pustular reaction in the skin, particularly those which are pathogenic on animals, e.g., cats, dogs, horses and cattle

4 The deeper portion of the skin may be attacked with the production of granulomatous lesions

5 Eczematous lesions may be produced

Ringworm Infections of the Glabrous Skin — These may produce the following varieties of lesion —

1 *Scaly Macular Type* — A pink scaly macule is the initial lesion which spreads peripherally by a slightly raised and slightly erythematous edge and involutes in the centre, which remains scaly

2 *Papular Type* — The lesion begins and spreads in the same manner as the macular form, but there is more infiltration. Owing to the centrifugal spread, which is not quite regular, figures with polycyclic outlines are sometimes produced. Sometimes one figure is seen within another

3 *Vesicular Type* — The lesions begin sometimes with papules, sometimes with vesicles. They spread peripherally from the central focus, involute centrally to some extent and leave behind furfuraceous scales and sometimes crusts of dried serum. The vesicles rest upon a reddened, often infiltrated base

4 *Pustular Type* — The lesions begin as dull red papules which soon become pustules. They spread peripherally to form a solid elevated disc or plaque, round, oval, or irregular in outline, and tend to clear up partially in the centre

5 *Granulomatous Type* — The infection is usually derived from cattle. The beard in man is most commonly attacked and occasionally the scalp in children. The lesions are circumscribed indolent tumour-like nodules or plaques involving both the subcutaneous tissue and the skin

6 *Eczematous Type* — Eczematoid ringworm, indistinguishable from eczema, occurs on the dorsum of the hands and feet about the ankles, wrists, elbows, and in other places. Such cases may be due to one or other of the trichophytia

but eczematoid lesions are more commonly produced by a particular organism, namely, the *Epidermophyton inguinale*

Epidermophytosis—The causative organism, the *Epidermophyton inguinale*, is of tropical origin. It is believed to have been introduced into England by schoolboys sent to English public schools from the East. It has become thoroughly established in the public schools, and is also to be found in swimming baths, Turkish baths, clubs, hotels and similar institutions. The disease appears to be increasing in England. The fungus grows best in the presence of warmth and moisture and it finds these conditions especially in the inguino-crural regions the axillæ and the interdigital folds of the feet. There are five clinical forms of epidermophytosis.

(a) *The Macular Form (Dhobie Itch)* attacks chiefly the upper inner thigh, both thighs are usually affected, the left more often than the right owing to the contiguity of the scrotum. The lesion spreads from the initial focus in all directions, but stops short as a rule below, at about the level of the scrotum, though in exceptional cases it may descend down the thigh as far as the knee. It may invade the perineum and the intergluteal fold, but almost always spares the inguino-crural fold. The scrotum may be attacked with the production of superficial redness, or raw, moist patches, the pubes, axillæ, umbilicus, and submammary folds are often affected, but never the hair. Scattered patches round and sometimes ringed, are occasionally found on the surface generally.

The lesions are irritable red scaly and sharply outlined. There is less tendency to central clearing than in other forms of ringworm infection.

(b) *Vesicular or Dysidrosiform*—This variety may be clinically identical with the condition known as dysidrosis or cheiropompholyx, the palms, soles, and lateral aspects of the fingers and toes are mainly affected.

(c) *Macerated Form*—The spaces between fingers and toes are attacked, especially the latter. The fourth interdigital cleft is always affected owing to its greater depth. The epidermis is thickened, sodden, and tough, and can be detached only with difficulty from an underlying raw surface. The periphery of the lesion presents vesicles, or the epidermis may be undermined with a ragged free edge directed towards the centre.

(d) *Fissured Form*—This form is often associated with the preceding. The natural skin folds running transversely across the under surface of the base of the toes are frequent sites

(e) *Hyperkeratotic Form*—The soles of the feet are affected less often the palms, the horny layer being thickened and scaly, there is no clear demarcation of the affected portion from the healthy skin -

Ringworm of the Nails—Whatever type of ringworm infection is the cause, the nail lesions are always similar. The usual changes are thickening with friability, vertical striation, and separation of the nail from the nail bed -

Erythrasma—This condition, though not related to the epidermophyton infections, is also found in the inguinocrural region and the axillæ. It consists of well-defined, clearly circumscribed, reddish-yellow patches with furfuraceous scales which do not itch. The cause is the *Microsporon minutissimum*.

Pityriasis Versicolor.—Although usually included in ringworm infections, this disease falls more naturally into line with the group of epidermal fungus infections caused by organisms resembling yeast, such as thrush, monilia and pityrosporon infections. The causal organism, *Microsporon furfur*, has a predilection for covered parts. It affects chiefly the chest, abdomen, back, and shoulders, and is most commonly found in subjects with an active sweat and sebaceous secretion. The disease consists of irregular macular light brown areas, which at first sight do not always look scaly, but on gently scraping they are easily seen to be so. The furfuraceous scales can be easily detached, and on microscopic examination in liquor potassæ the fungi are readily seen as grape like clusters of spores disposed about short strips of mycelium.

Ringworm of the Scalp—The scalp is very rarely infected with ringworm in adult life, but it is common at all ages up to puberty. The commonest cause is a small spored fungus of human origin, *Microsporon Audouini*. Occasionally the infection is derived from animals, in which case the fungus may be a small spored species, or more occasionally large spored.

Microsporon Audouini Infection of the Scalp—The horny layer of the epidermis of the scalp is first attacked with the production of a round or irregular scaly patch. The infection then spreads downwards into the follicle encircling the hair. Just above the hair bulb the cuticle becomes frayed, and allows the mycelium to penetrate the hair. The mycelium then works upward beneath the cuticle, and for a short distance downward, but never reaching the bulb. From the subcuticular layer of mycelium, spores are produced which penetrate the hair and coalesce to form a mosaic of spores. This extends upwards beyond the intrafollicular portion of the hair. The

hair is rendered brittle, and usually breaks a few millimetres or more above the surface of the scalp. As the bulb is not infected the hair continues to grow and to break off.

Clinically *tinca capitis*, as this condition is known can be recognised by the presence of scaly patches with broken lustreless hairs the normal directions of which are not followed. In addition there is often accompanying erection of the follicles. In some cases there is a moderate degree of inflammatory change in the form of superficial follicular pustulation. This is common in infections of animal origin. A special variety of pustular ringworm of the scalp, known as *Kerion Celsi* invades the hair follicles more deeply. It gives rise to one or more raised disc like granulomatous plaques from which the hairs loosened by suppuration are eventually shed spontaneously. Another special variety in which the infected hairs break off flush with the scalp appearing in the form of tiny black dots, is known as black dot ringworm.

Microsporon infection of the scalp may be detected by Wood's light illumination. If the light from a mercury vapour lamp is passed through nickel oxide glass the luminous rays are cut off. If the scalp is viewed in a dark room under the rays that pass hairs infected with *microsporon* fluoresce a bright green colour. In this way a single infected hair can be detected. It is thus a valuable test of cure as well as a simple method of diagnosis. Black dot ringworm does not fluoresce.

Ringworm of the Beard (*Tinea Sycosis*) may occur in two forms a superficial variety which may be macular papulo-vesicular or pustular, or a suppurating granulomatous type resembling *kerion* of the scalp. The lesions of the latter type are discrete boggy swellings the follicles may be converted into wells of pus or suppuration may be hardly apparent though it is always possible to express droplets of pus from the follicles. The hairs are easily extracted with forceps and in the course of weeks or a few months are spontaneously shed.

Trichophytides—The suppurative varieties of ringworm infection are occasionally complicated by eruptions of generalised distribution. These appear some weeks after the onset of the infection and usually when the initial lesions are beginning to involute. The commonest variety is that known as *Lichen Trichophyticus* usually complicating *Kerion Celsi* in children this consists of small acuminate follicular papules, often capped by a filiform horny spine, occurring chiefly in groups on the trunk and limbs, the eruption bears a close resemblance to *Lichen Scrofulosorum*. *Erythema multiforme*

or urticaria complicating deep ringworm infection or epidermophytosis are less common forms of trichophytide

The trichophytides are due both to the absorption of trichophytic toxin from the initial focus, to which the individual becomes sensitised, and to the dissemination in the blood stream of living fungi

TREATMENT

Ringworm Infections of the Glabrous (non-hairy) Skin—The macular, papular, vesicular, and pustular forms are easily cured by the application of tincture of iodine or Whitfield's benzoic acid ointment (*vide* Therapeutic Section) Mild mercurial ointments are also efficacious Whitfield's ointment is particularly suitable for the macular form of epidermophytosis The rather rare granulomatous forms are best treated by mercury perchloride fomentations of 1 4,000 strength

In resistant cases a mixture containing 15 30 gr of potassium iodide, or 5 10 minims of 10 per cent tincture of iodine, should be given by mouth three times daily

The interdigital variety of epidermophytosis of the feet often requires prolonged and energetic treatment When the interdigital spaces are lined by tough, sodden epidermis it is best to remove this to begin with by means of a 12 per cent solution of salicylic acid in spirit This should be applied each night until all or the greater part of the horny material has been removed A fungicide paint, such as the carbol fuchsin paint advised by A Castellani, or chrysarobin paint (*vide* Therapeutic Section) may then be applied twice daily

For the vesicular eruption of the feet and hands Whitfield's ointment or a fungicide paint may be applied once or twice daily after bathing the feet in eusol for about ten minutes

In cases of recent origin in which horny accumulation in the spaces is not pronounced a less concentrated solution of salicylic acid in spirit, or one containing salicylic acid and benzoic acid (*vide* Therapeutic Section), may be used in the preliminary stage of treatment

Ringworm of the Nails—Complete removal of the nail and curettage of all infected horny tissue may effect a cure This must be followed by treatment with a strong fungicide preparation, such as 4 per cent chrysarobin ointment, until a new healthy nail has grown When recurrences occur in spite of the above treatment the infection can only be eradicated by operative removal of the nail matrix

Ringworm of the Beard.—For superficial infections a

fungicide ointment is rapidly effective. The granulomatous kerion like lesions clear up gradually with mercury perchloride fomentations of 1 : 4 000 strength.

Ringworm of the Scalp—With the exception of Kerion Celsi, in which the hair is loosened by peripheral suppuration and spontaneously shed, and which is easily cured by local fungicide applications or by mercury perchloride fomentations, it is necessary first to epilate the hair before applying a fungicide remedy. Epilation may be accomplished (a) by the artificial production of follicular pustulation, (b) by X ray.

The first method of treatment may be carried out by shaving the scalp, carefully outlining the infected patches, and painting these areas daily with croton oil for twelve to fourteen days. By this means a condition resembling kerion may be produced, and in such a case the treatment will be successful, for the hair will in time be shed spontaneously. More often, however, superficial follicular pustulation results, which while loosening the hairs somewhat, will necessitate their careful removal with forceps. This proceeding is extremely difficult and tedious.

Epilation by X ray is the most satisfactory method of treating ringworm of the scalp. A single epilating dose is given, and the whole scalp treated. The hair falls out in nineteen to twenty one days and it is not difficult to cure what has now become ringworm of a non hairy surface. Unfortunately, there is a risk of some degree of permanent alopecia, though when the treatment is carried out by an expert the danger is very small.

DERMATOSES CAUSED BY ANIMAL PARASITES

Several insects and acari are able to live on the human skin and cause characteristic eruptions. The most important of these are the Pediculi (*P. capitis*, *P. pubis*, and *P. vestimentorum*), and the *Acarus Sarcoptes scabiei hominis*, responsible for scabies.

PEDICULOSIS

There are marked differences in the size and shape of these insects, by which they may be easily identified from one another. The body louse is the largest, the pubic the smallest. The latter is broader in proportion to its length than the other two. Pediculi are provided with a pyriform head containing two jaws by which the skin is grasped, and a sucking organ. The females are more numerous than the males, they lay large

numbers of eggs provided with a chitinous envelope. These are found attached by a pedicle to the hair in the scalp and the pubic varieties, and in the clothing and on lanugo hairs in the case of the body louse. The eggs hatch out within a week, and they are mature in a fortnight. Multiplication therefore, takes place at an enormous rate.

Pediculosis Capitis—The insect lives chiefly in the scalp of children, but is quite commonly found in women. It appears less often in men, because the ova are not easily deposited on short hairs. The lesions produced by the presence of *P. capitis* vary within wide limits according to the susceptibility of the individual. Some persons are able to harbour enormous numbers of the insect without symptoms, but in others the irritation set up by the bites produces eruptions of varying severity, with more or less severe pyogenic infection. Pyoderma-*matitis* may be in the form of impetigo or a pustular folliculitis, and it may be accompanied by abscesses of the scalp. In severe cases the hair may be matted together by crusts of dried serum which overlie a scalp bathed in pus (*Plica polonica*). In such cases, as well as in milder ones, the prodermatitis extends sometimes to the post auricular grooves, the neck, shoulders, and upper part of the back. Linear scratch marks, excoriations, and pyodermatitis may be present in these regions also without lesions in the scalp, owing to the fact that the pediculi are able to leave the scalp for feeding purposes, though not for propagation. Serious sequelæ of *Pediculosis capitis* are often met with in the form of impetiginous dermatitis and chronic folliculitis of the scalp, blepharitis, and post auricular impetiginous eczema. The glands in the neck may be secondarily enlarged.

Pediculosis Corporis—The body louse is larger than the head louse and lives on the non hairy parts of the skin, while the ova are deposited chiefly in the seams of the clothes, but are found also attached to lanugo hairs. The type and degree of the eruption varies with the susceptibility of the individual. Adults and aged persons are mainly attacked. The lesions are found in places where the clothes are in close contact with the skin, such as the shoulders, scapular regions, the posterior axillary folds, the abdomen, and the anterior aspects of the thighs. The forearms and hands, legs and feet are rarely attacked. The bite of the insect causes an urticarial wheal of more or less intensity. Linear excoriations caused by scratching are also present. Pigmented patches are found in prolonged cases, and in the most severe forms the skin may become thickened from incessant scratching, and almost,

uniformly pigmented. Sometimes pigment may be found in the buccal mucous membrane. A certain degree of debility accompanies *Pediculosis corporis* in some cases, and is attributed to a toxin introduced by the insect. The pigmentation is believed to be of like origin. *Pediculi corporis* are responsible for the transmission of typhus.

Pediculosis Pubis — *P. pubis*, or the crab louse, lives on the pubic region, but invades the neighbouring portion of the thighs and abdomen as well. The axillary hairs, eyebrows, and eyelashes are occasionally invaded, particularly in aged subjects. Infection is generally though not always acquired through sexual intercourse. The insect is provided with claws by which it is able to grasp a hair. It feeds by plunging its head into the mouth of the follicle bearing the hair to which it is attached. The ova are found attached to the hairs close to their bases. The bites give rise to more or less severe itching, and often a follicular pustular eruption on the pubes, inner aspects of the thighs, and lower portion of the abdomen. In addition, pigmented patches of a peculiar slate blue colour are sometimes found on the abdomen or thighs. These are pathognomonic of the disease.

Treatment — *Pediculosis Capitis* — A close haircut is naturally the simplest way of curing the condition. It is necessary in cases complicated by severe pyogenic infection, for female children and women, however, this drastic remedy is undesirable. The treatment which has been adopted by most of the cleansing stations in London at a time during air raids when pediculosis capitis was extremely prevalent is as follows —

The hair is first moistened with tar oil and live vermin combed out with a Gins comb. The hair is then washed with soft soap and borax (borax, 1 oz. soft soap $\frac{1}{2}$ lb., hot water, 1 quart). After five minutes the hair is rinsed and while wet, combed with a Sickers comb to remove nits. The hair is then dried. Three or four treatments appear to be effective.

Pediculosis Corporis — Sterilisation of all clothes and bed clothes is essential. Stavesacre ointment is a satisfactory local application, and should be used thoroughly.

Pediculosis Pubis — The pubic hair and as much of the thighs as are infected should be shaved. The same local application as for *P. corporis* is suitable. The infection is easily removed.

SCABIES

This common parasitic disease is caused by an acarus, *Sarcoptes scabiei hominis*. The female penetrates the epidermis

and burrows immediately beneath the horny layer, depositing ova in her progress. The presence of the parasite gives rise to a vesicle of about the size of a pin's head or larger, in which the acarus can sometimes be seen as a tiny white spot. Runs only occur in certain sites of predilection. These are about the wrists, and particularly the ulnar margin, the interdigital folds, sides of the fingers, the ulnar margin of the hand, the axillary folds, the penis and scrotum, the ankles and sides of the feet. In children burrows are also found on the palms and soles. The ova hatch out in 60 to 100 hours or longer, the larval parasite makes its own burrow, which is said to be marked by a vesicle, succeeding stages, nymph and adult male, nymph and immature female, also burrow and probably wander as well but the mature female, having made her burrow (the run) does not move from it.

Maturity is reached in eight days or longer from the laying of the egg. No stage is likely to survive more than a day or two without food. The lesions of scabies are of three types: (1) runs consisting of dirty greyish lines, straight or sinuous, and usually less than $\frac{1}{2}$ cm long, terminated by a vesicle containing the female parasite, (2) vesicles, (3) papular lesions. The two last are found on the hands, fingers and wrists, the feet, the legs and forearms, the sides of the chest, the abdomen, the inner aspects of the thighs and the genitals, and in the natal clefts. They occur in greatest numbers in the immediate neighbourhood of the breeding grounds, becoming more sparse in the intervening areas. A group of papules on the point of one or both elbows is almost always present in well developed cases. The face and scalp are always spared, and the neck is hardly affected. The back also is attacked to a minor degree, or not at all.

The distribution of the lesions contrasts with that of *Pediculosis corporis*. The eruption itches intensely, especially in bed, and causes much scratching. Accessory lesions in the form of linear excoriations, pyoderma and traumatic eczema are common. Scabies is the most frequent cause of eczema of the nipple in women. Unfortunately both complications may be very troublesome, as experience during the present war has shown. In babies and young children scabetic lesions on the wrists, hands, and fingers are generally far more numerous than in adults, and a severe pyoderma of the hands is not uncommon. This infection and the eczematization which may accompany it add considerably to difficulties in treatment. In adults also, particularly those with fair sensitive skins, infection and eczema may mask the underlying scabies.

According to L. Mellanby, scabies is probably transmitted almost entirely by skin contact. He tried to infest volunteers through clothes and bedding. With bedding he failed altogether, and of thirty two who wore clothes immediately after they had been worn by scabetic patients, only two subsequently developed scabies, with longer intervals no infestation took place. Three out of four volunteers who slept with scabetic patients became infested, the earliest lesions appearing from eight to twelve days later. He found that no complaint of itching may be made for six or seven weeks.

Treatment consists of the thorough application of one of several remedies (*vide p. 1117*), of which benzyl benzoate appears to be accepted at present as probably the most efficient. A bath is taken, the patient covered with soft soap and scrubbed, immediately after the bath, a mixture of benzyl benzoate, soft soap and spirit in equal parts is brushed on all over from the neck downwards. This gives rise to stinging which, however passes off in about half an hour. Two or three such treatments are generally enough. When an ointment is used the treatment is a little more prolonged. After the preliminary hot bath and scrubbing, the ointment is rubbed in thoroughly from the neck downwards and reapplied twice daily for the following three or four days, a final bath is taken at the end of this period and a complete change of clothing made. At the end of treatment clothes and bedclothes should be changed or disinfected by heat.

All these treatments cause some irritation and dermatitis is a common sequel after treatment with sulphur ointments the skin especially in fair skinned subjects and in children, may become red and scaly. In some cases the patient assumes that he is not cured and adds to the trouble by further treatment. Dermatitis also occasionally follows treatment with benzyl benzoate owing to allergic sensitivity, in such cases the dermatitis is severe though fortunately short lived.

Eczema complicating scabies requires special treatment after the parasitic infection has been dealt with. White's crude tar paste diluted with one or two parts of zinc ointment is useful in these cases (*vide Therapeutic Section p. 1119*).

SCLERODERMA AND DERMATOMYOSITIS

Scleroderma — There are two main types

- 1 Generalised or progressive symmetrical scleroderma
- 2 Circumscribed scleroderma, or morphea

Generalised Scleroderma.—The disease opens frequently with Reynaud's phenomenon, and this may precede other changes by weeks or months. The next phase is commonly one of œdema; the face, hands, and forearms are first attacked, œdema is replaced by sclerosis, sometimes so superficial that it can hardly be appreciated, sometimes dense enough to impede movements of the arms, fingers, and legs; inability to extend the fingers fully, a change spoken of as sclerodactyly, is particularly common. In the fully developed disease the sites of election are the face, the neck, and the adjoining parts of the chest and back; the fingers, hands and forearms, and the feet and legs. It may be almost universal.

The face has a peculiar and quite characteristic mask. The lips are thin and drawn over the teeth, the nose is pinched, the forehead devoid of wrinkles. Small telangiectatic tufts are present on the cheeks.

Skeletal myopathy is constant, and it is independent of overlying scleroderma; it varies from slight myasthenia, accompanied usually by some pain, to extreme weakness and atrophy with dysphagia and nasal speech; in such cases respiration eventually becomes impeded owing to involvement of the respiratory muscles.

Pathology.—The connective bundles of the skin lose their fibrillary structure, becoming condensed and homogeneous. In the muscles the change is that of a degenerative myopathy; it occurs in patches and varies from loss of striation to complete disintegration.

The thyroid gland is involved in the process, the changes varying from that of a colloid goitre with increase of stroma in an early case, to atrophy and fibrosis after many years. Other endocrine glands do not appear to undergo any gross anatomical change. Calcium is sometimes deposited in the skin, and osteoporosis is found occasionally. Creatinuria is constant.

Ætiology.—The disease may occur at any age, but adults are more often attacked than children; two congenital cases have been recorded. The significance of the changes found in the skin, blood vessels, muscles, and thyroid gland is unknown.

Prognosis.—Severely myasthenic cases may be fatal within a year, death is generally due to broncho-pneumonia; the majority persist for years without much change; a small number recover spontaneously.

There is no known rational treatment.

Circumscribed Scleroderma (Morphœa).—This begins with a violaceous erythematous plaque; it extends gradually, becom-

ing ivory white in the centre and indurated. The plaque is bordered by a violaceous zone often spoken of as the lilac ring. This marks the zone of extension of the process. There may be one or several patches of variable dimensions and shape. The process comes to an end in the course of several months or years and is replaced by atrophy, often pigmented.

Etiology—Little or nothing is known of the cause of circumscribed scleroderma. It has occurred occasionally in cases of Graves' disease. Whether it is related or not to generalised scleroderma is unknown.

Treatment—There is no satisfactory treatment. Definite improvement is however said to follow the application of Thorium A ointment.

DERMATOMYOSITIS

The opening cutaneous symptoms vary in degree. There may be erythema and œdema of the face and eyelids. More often the face, neck and chest and the extremities are involved and occasionally there is extreme œdema of universal distribution. This phase may persist with fluctuations for months, often accompanied by intermittent fever. With gradual subsidence of the œdema the skin becomes the seat of variegated change consisting of telangiectases, pigmentation, depigmentation, superficial roughness and very superficial sclerosis or atrophy.

At this stage the sites of election are the face, the scalp, with gradual loss of hair, the neck and the adjoining parts of the chest, back and shoulders, the backs of the fingers and hands and the forearms and arms, especially along their extensor aspects. The legs and thighs may also be attacked and there may also be areas of the same change of the lower part of the abdomen and back. In exceptional cases the skin changes are limited to the face and hands and they may be quite insignificant, the case presenting then the picture of an almost pure myopathy.

Muscular Symptoms—Weakness accompanied usually by dull pain may begin almost at once or it may not be noticed for several weeks or months. It varies from fatigue or inability to get up easily from a low chair to extreme prostration with dysphagia and nasal speech. In time the muscles become wasted, abnormally firm in consistency and retracted so the arms cannot be fully extended.

Prognosis—Severe cases are sometimes fatal within a few months, others pursue a smouldering course for years and

some recover completely. Death is most often due to broncho pneumonia.

Pathology—In the skin superficial sclerosis is found. In the muscles the change is the same as that found in progressive scleroderma. Creatinuria is constant. Exceptionally there are deposits of calcium in the skin, and osteoporosis has also been seen.

Etiology—The disease is more common than is usually supposed. It occurs at all ages, though young adults are the most frequent victims. That dermatomyositis and progressive scleroderma represent, as Langmead and others have pointed out, different aspects of a common morbid process is evident from the close similarity of the symptoms and pathology of the two conditions, as well as from the fact that every possible grade of transition between them has been seen.

Treatment—Complete rest is necessary until definite improvement has become manifest. There is no known curative remedy. In chronic cases physical effort should be restricted to that which can be accomplished without distress, generally very little. Improvement may set in even after years of weakness.

THE ALOPECIAS

The Alopecias may be divided into two clinical groups

- 1 Diffuse alopecia affecting the whole scalp
- 2 Alopecia in circumscribed patches.

Diffuse Alopecia—These are either symptomatic, developmental, or congenital.

Symptomatic alopecia follows an acute infection such as erysipelas, typhoid fever, or influenza, and occasionally uncomplicated parturition. The hair begins to fall about six weeks after the illness, continues to fall for about the same period, and finally it regrows gradually but completely.

The alopecia that occurs sometimes in secondary syphilis has a special character, it is uneven, the scalp is riddled with clearings and irregular paths (*alopécie en clairières*). It also is temporary.

Developmental Alopecia—The common baldness of the male requires no description. It begins most often in middle life, but often prematurely. It is gradually progressive, and no recovery is possible. Heredity is the chief factor, that endocrine factors are also concerned in it is evident from the

fact that it is not seen in women. Aristotle observed that children and eunuchs never became bald, and Sabouraud said that this observation had been confirmed by a careful examination of the scalps of 350 Turkish eunuchs.

In women, particularly those with fine hair and an oily scalp, a gradually progressive loss of hair affecting principally the vertex, is not uncommon. It is accentuated at the menopause but, unlike the masculine type it never becomes complete. As in masculine baldness heredity is an important factor.

The rare congenital alopecias are three in number known respectively as congenital ectodermal defect, monilethrix and pili torti.

Circumscribed Alopecias—These may be divided into four groups.

1 Those which follow pyogenic infections of the scalp such as impetigo, boils or kerion Celsi: the hair usually regrows.

2 Cicatrizing alopecias. Apart from injuries and burns permanent loss of hair with scarring may be the result of lupus erythematosus, lupus vulgaris, gumma fixus, radiodermatitis, scleroderma, lichen plano pilaris, folliculitis decalvans and pseudo pelade.

3 Trichorrhexis nodosa. The condition occurs in patches the hair of which is fuzzy and broken off short often close to the scalp. Fracture takes place at the site of tiny swellings which can be seen with a lens and which under the microscope are seen to resemble the partial fracture of a green stick. Sabouraud compared the condition to that of old shaving and other brushes and believed hair waving or dyeing or the excessive use of shampoos to be responsible but it often persists for years in spite of the strict avoidance of such causes. Rarely the hair becomes normal within a year or two.

No treatment appears to be of any value.

4 Traumatic alopecias. A patch of baldness corresponding to the part of the head in contact with the pillow is often seen in infants. The hair is rubbed away by constant rolling of the head on the pillow.

Fausse Pelades—Patchy alopecias have been observed in epidemic form among children in institutions. They are thought to have been due to rubbing. The starting point has sometimes been the presence among the children of a case of alopecia areata.

Trichotillomania—This is met with most often in children, and it is a symptom of restlessness like nail biting. The child develops the habit of twisting or pulling the hair, which he

pulls out or breaks off close to the scalp. The diagnosis is made by the discovery of broken hairs of different lengths.

Alopecia Areata—The condition may consist of (1) Circumscribed patches of roughly circular outline (2) large irregular patches (3) complete loss of hair sometimes involving the whole surface.

Symptoms—The fall of hair is preceded by faint erythema of a salmon pink colour without subjective symptoms. As a rule the alopecia which follows is complete but scattered hairs of normal length are occasionally seen in the patch these yield however to the slightest traction. In addition a number of short broken hairs are usually present these are broader and pigmented at their free extremities while the roots are depigmented and atrophied. The presence of these hairs which are known as exclamation mark hairs indicates that the process is spreading actively.

Alopecia areata varies greatly in extent and duration. Cases in which only a few small patches are present may recover in some months. Widespread cases are more persistent though the majority recover eventually. Those in which all the hair is lost may not recover or partial or complete recovery is followed often by relapse from which no recovery is to be expected. Regrowth begins in the form of downy hair which eventually becomes replaced by fully developed hair this may be white at first but it usually becomes pigmented later.

Ætiology—Very little is known about the cause of this common condition. Heredity plays a part in a small percentage of the cases. Like vitiligo with which it is rather rarely associated it is believed to be the result of a functional disturbance of the sympathetic nervous supply of the skin or hair. A direct injury to the head has preceded certain cases.

The widespread belief that nervous stress or shock are common causal factors is only occasionally supported by the case histories. Alopecia areata occurs rarely in the course of Grave's disease.

There is no known rational treatment. It is customary to apply stimulating lotions or ultra violet light in erythema do es

DISEASES DUE TO FILTERABLE VIRUSES

Four conditions are known to be caused by filter passing viruses they are Herpes Zoster Herpes Simplex Verruca and Molluscum Contagiosum. Herpes zoster has been described elsewhere (vide p. 843).

Herpes Simplex—*Symptoms*—The lesion consists usually of a single group of vesicles but there may be two or several groups often disposed symmetrically. The vesicles dry up in the course of four or five days leaving a crust which separates several days later. Herpes occurs most often on the face especially about the mouth and on the genitalia but any part may be attacked including the buccal and urethral mucous membranes. There is a marked tendency to recurrence often at regular intervals and in the same place.

Etiology—Herpes occurs at all ages from childhood onwards it has been transmitted from man to man with some difficulty and from man to the rabbit with great ease. It may occur in the course of almost any fever and in coryza but often independently of any other infection. Its cause is a filterable virus identical with that of herpetic encephalitis in rabbits.

Treatment—The application between attacks of two or three small doses of X ray to the site of infection is sometimes followed by an unusually long period of freedom. The lesion itself is best treated by the application of a bland powder.

Verruca—Warts are hard epithelial elevations they have a rough horny papilliferous surface and they are usually of a greyish colour. They vary in dimensions and in degree of elevation. They may be flat as in the variety known as juvenile warts raised and sessile in verruca vulgaris filiform or pedunculated or they may be to some extent embedded in the skin as in the plantar and palmar types. Plantar and palmar warts are less raised than warts of similar size in other parts they bear some resemblance to corns from which they can be distinguished as a rule by the presence of a slight crater like central depression. They are nearly always painful and interfere with walking. Warts are often present on the nail folds extending occasionally beneath the nail to the nail bed.

Etiology—A wart is essentially an epithelial hyperplasia the stimulus is a filterable virus. Warts are auto inoculable and slightly infectious. Small epidemics especially of plantar warts are not uncommon in boarding schools.

Treatment—For the common wart freezing with carbon dioxide snow is the most useful all round remedy. A little acetone is added to the powdered snow to make a mush and this is applied with a camel's hair paintbrush. Each wart must be kept frozen for at least two or three minutes. Large warts generally require several treatments at intervals of about a fortnight.

Flat warts require freezing for five or ten seconds only,

or they may be treated by the application of Thorium X or trichloroacetic acid, or by gentle fulguration

Plantar warts are best treated by the single application of a large dose of X ray, the surrounding skin being well screened with lead foil, alternatively, after curetting the wart out of its bed with a sharp spoon, the cavity is touched with the cauter or fulgurated

Paronychia warts are difficult to treat when partly situated under the nail. This makes necessary removal of the nail or part of it before treating the wart by freezing or curetting

Warts fortunately have a tendency to disappear spontaneously, and this happens occasionally when one or two of a considerable number have been disposed of by treatment

Molluscum Contagiosum—This not uncommon condition is seen most often in children. The lesions consist of epithelial tumours which vary in size from a pin's head to a pea. At first barely perceptible they enlarge slowly to form round tumours resembling pearls. Each has a shallow central umbilication through which a creamy mass can be expressed by lateral compression

This material is found on microscopic examination to contain large round or ovoid epithelial elements without nuclei known as molluscum bodies, and a quantity of amorphous debris. There may be from a few lesions to hundreds some only to be seen with a lens

Secondary infection of the larger elements is common

Ætiology—Molluscum contagiosum is both contagious and auto inoculable. It is most often seen in summer and swimming baths are probably the chief source of infection. It is like verruca an epithelial tumour, and the stimulus is a filterable virus

Treatment—Each lesion is treated separately, the central soft portion is expressed and a pointed match moistened with pure carbolic acid or tincture of iodine is inserted into the opening. They may also be treated by electro coagulation

EXTERNAL TREATMENT

Cutaneous lesions often require treatment by surgery the galvanocautery electro coagulation electrolysis, carbon dioxide snow, X ray, and radium. For information concerning such methods the reader is referred to works on dermatology

In addition local applications of various kinds are of great importance in the treatment of disease of the skin. Sometimes

the restoration of superficial damage is best achieved by attention to cleanliness and the application of protective lotions, liniments, creams, or pastes. In other cases it is desirable to use chemical agents having bacteriostatic, antiseptic, fungicidal, or antiparasitic properties, or rubefacients, reducing and caustic agents. Some of these may be incorporated into powders, lotions, creams, pastes, ointments, and paints, while occasionally they are used in the pure state.

It is not necessary to employ a large number of remedies

Cleansing Agents—It is useless to apply a remedy to a lesion which is covered with a crust or scab until the latter has been removed. Water, being hypotonic, exerts a macerating action on damaged tissues and is generally unsuitable for this purpose, normal saline may, however, be used. Simple lotions, to which small quantities of antiseptics may be added if necessary, often serve the double purpose of cleansing and protecting a damaged skin. The starch and boric poultice is a valuable cleansing agent. To four tablespoonfuls of starch are added one or two teaspoonfuls of boric acid and enough cold water to make a thick paste. Boiling water is added slowly with continuous stirring until the starch bursts. The poultice is spread out thickly on linen or lint, and the surface to be placed against the skin covered with butter muslin.

Protective and Soothing Remedies—An acutely inflamed surface requires an application with cooling and soothing properties such as a simple lotion, liniment, or powder. Lotions and oily liniments by facilitating drainage are suitable applications for weeping surfaces. Serous oozing or weeping is generally succeeded by desquamation, which is usually the result of parakeratosis. The superficial cells have not undergone their normal transformation into the homogeneous horny layer and are lacking mainly in fat. Creams, pastes, and ointments are used to supplement this deficiency until the normal horny layer has been reformed. To these other substances with anti-pruritic or mildly stimulating properties may sometimes be added.

Calamine Lotion—

Prepared calamine, 15 grains
Zinc oxide, 15 grains
Glycerine, 20 minims
Lime water to 1 fluid ounce
Solution of coal tar, $\frac{1}{2}$ 1 fluid drachm,
or phenol, 5-10 grains, may be added
to each fluid ounce to allay pruritus

Indications

May be used for erythema, urticaria, the erythematous and early vesicular stage of eczema, and eczematous dermatitis

Watery Paste—

Zinc oxide, 24 per cent
Titanium oxide, 21 per cent
Colloidal kaolin 8.5 per cent
Glycerine, 15.5 per cent
Water, 31 per cent

(Semon, H. C., and Hermann, F.)
btuolam, B. D. H.
Acute weeping or erythematous dermatitis

Lead Lotion—

Diluted solution of lead subacetate
B. P.

Indications as above

Calamine Liniment—

Zinc oxide,
Calamine, of each 480 grains
Powd. gum tragacanth, 60 grains

Suitable for the vesicular and weeping stage of eczema

Protective and Soothing Remedies—continued

Calamine Lintment—continued

Phenol 10 grains
Glycerine, 10 minims
Olive oil 4 fluid ounces
Water to 20 fluid ounces

Creams—Creams are fatty preparations containing water

Ichthyol Cream—

Ammonium ichthosulphonate, 2 to 5 grains
Zinc oxide, 1 ounce
Anhydrous lanolin, 2 drachms
Olive oil, 1 fluid ounce
Lime water, 6 fluid drachms
Lanolin of each 10 drachms
Zinc oxide, 4 drachms

Indications

Desquamative stage of eczema.

Pastes—These are preparations having usually a fatty or petroleum base in which starch is incorporated.

Compound zinc paste (Syn Laasar's Paste) B P C

Salicylic acid, 2·0
Zinc oxide, 24·0
Starch powder, 24·0
Soft paraffin, 50·0

Indications

A protective paste suitable for eczema in the desquamative stage

Ointments—

Soft paraffin, 150 grains
Glycerine of starch, 150 grains
Lanolin to 1 ounce

Emollient ointment suitable for ichthyosis

Powders—

Boracic acid powder, 10·0
Starch powder, 10·0
Oil of geranium 0·2
Purified talc to 100·0
(Mix and sift)

Local application for herpes catarrhalis herpes zoster, intertrigo, dermatitis. Vapour erythema, intertriginous erythema, erythematous stage of eczema.

Antiseptics.*Lotions*—

Alibour water (Guy's Hospital formula)
Copper sulphate, 2·0
Zinc sulphate, 7·0
Saturated aqueous solution of camphor, 300·0
(Dissolve and mix)
Mercuric chloride, $\frac{1}{4}$ grain
Sodium chloride, 5 grains
Water to 1 fluid ounce
(Dissolve and mix.)

For removal of crusts and for cleansing the surface of impetigo contagiosa, Boeckhardt's impetigo, and pyodermatitis in general. Must be diluted with 5 to 10 parts of water

As above

Paints—

Silver nitrate, 5 to 20 grains
Spirit of ultrous ether, 1-fluid ounce
(Dissolve)

Indications

For painting on fissures caused by atreptococci

Antiseptics—*continued**Pastes—*

Precipitated sulphur, 30 to 45 grains
 Zinc oxide, 60 grains
 Kaolin B.P., 15 grains
 Benzoated lard to 1 ounce

Indications

Bockhardt's impetigo, figurate
 type of seborrhoeic dermatitis,
 pustular acne

Ointments—

Ammoniated mercury, 5 to 20 grains
 Soft paraffin to 1 ounce

Yellow mercuric oxide 5 to 10 grains
 Soft paraffin to 1 ounce

Impetigo contagiosa, pyoderma-
 titis

As above

Powder—

Powdered sulphanilamide

As above

Fungicide Preparations

Paints—

Chrysarobin, 60 grains
 Acetone, 3 fluid drachms
 Rectified spirit to 1 fluid ounce

Indications

Ringworm, especially epidermo-
 phylosis of interdigital folds

Benzolic acid, 25 grains
 Salicylic acid, 15 grains
 Acetone, 2 fluid drachms
 Rectified spirit to 1 fluid ounce
 (Dissolve and mix)

As above

Carbol fuchsin Paint (Castellani)—

Sat sol of basic fuchsin, 10 c c
 5 per cent aqueous sol of phenol, 100 c c
 Filter and add

Epidermophytosis

Boric acid, 1 gramme
 Allow to stand for two hours and
 add

Acetone, 5 c c
 Allow to stand for two hours and
 add

Resorcin, 10 grammes
 (Keep in a dark coloured and well
 stoppered bottle)

Ointments (Whitfield's ointment)—

Benzolic acid, 25 grains
 Salicylic acid 16 grains
 Soft paraffin, 120 grains
 Coco nut oil to 1 ounce

Ringworm of non hairy surface
 also of the scalp after epilation

Anti-parasitic Remedies

Ointments—

Prepared storax, 120 to 180 grains
 Prepared lard to 1 ounce

Indications

Scabies

Anti-parasitic Remedies—continued

Ointments—

Balsam of Peru, 15-0
 Prepared storax, 20-0
 Prepared chalk, 20-0
 Prepared lard, 45-0

Indications

Scabies

Stavesscre ointment B P.

Pediculosis corporis and pubis

Sulphur ointment B P

Benzyl benzoate

Soft soap

Spirit, of each equal parts

Keratolytic drugs, having the property of softening and destroying keratin and so producing maceration or exfoliation of horny tissue, may be incorporated into pastes, ointments, and other preparations. The most important is salicylic acid

Keratolytic Paste—

Resorcin, 10 0
 Camphor, 10 0
 Soft soap, 15 0
 Precipitated sulphur, 30 0
 Prepared chalk, 5 0
 Soft paraffin, 30-0

Indications

Acne vulgaris, particularly of the back and shoulders, should be applied for four or five days only, then followed by a milder sulphur paste or lotion for a week before repetition

Lotion—

Sulphurated potash, 2-0
 Rose water, 8-0
 (Dissolve solution No 1)

Acne vulgaris produces exfoliation. Solution No 1 must be made freshly once in three weeks

Zinc sulphate, 2-0
 Rose water, 8-0
 (Dissolve solution No 2, mix equal parts of Nos 1 and 2 for use)

Ointment—

Salicylic acid, 5 to 25 grains
 Soft paraffin to 1 ounce

Palmar and plantar keratoses, corns, psoriasis, and any condition in which a preliminary removal of accumulated horny material is necessary.

Reducing Agents—A number of chemical substances commonly used in dermatology have been designated reducing agents. Some of them, e.g., pyrogallol, chrysarobin, and leucogallol, are reducing agents in the chemical sense, but others such as tar, ichthyol, and sulphur, while having a similar therapeutic action, are not known to have an avidity for oxygen. Tar and ichthyol have anti pruritic properties.

Ointments—

Chrysarobin, 20 to 60 grains.
 Soft paraffin to 1 ounce
 (Mix)

Indications

Psoriasis

Solution of coal tar, 30 to 60 minims
 Ammoniated mercury, 10 grains
 Salicylic acid, 10 grains
 Paraffin ointment B P. to 1 ounce

Psoriasis

Reducing Agents—continued

Ointments—

Oil of cade, 30 grains
Sulphur, 10 grains
Salicylic acid, 10 grains
Soft paraffin, 120 grains
Coco nut oil to 1 ounce

Indications

Psoriasis of the scalp Chronic
seborrhœic dermatitis of the
scalp, pityriasis capitis

Pastes—

Solution of coal tar, 40 to 60 minims, or
ammonium ichthœosulphonate, 5 to 10
grains
Zinc oxide,
Starch in powder, of each 90 grains
Soft paraffin to 1 ounce

Lichenified and scaly eczema
Seborrhœic dermatitis of the
pityriasisiform, and the acute
and subacute follicular papular
types

Crude coal tar, 2 0 (C J White)
Zinc oxide, 2 0
Starch in powder, 16 0
Soft paraffin, 16 0

As above Especially useful for
lichenified eczema and for
infantile eczema

The tar and zinc oxide should be triturated thoroughly, also the starch and paraffin, then the two parts incorporated, resultant paste should be almost black. It may be diluted with one or two parts of zinc ointment

Caustics—The use of caustics for the destruction of warts and other cutaneous tumours is unsatisfactory, and has become largely superseded by carbon dioxide snow, the galvano cautery, electro coagulation, X ray, and radium. Certain caustics are, however, of value in the treatment of lupus, and their present extensive use is likely to continue. Trichloroacetic acid may sometimes be applied successfully to the treatment of warts.

Indications

Acid solution of mercuric nitrate

Exerts a selective caustic action
on lupus tissue. It is painted
on the lesions about once in
three weeks

Zinc chloride

Used as a solid stick for application
to lupus of mucous surfaces

100 per cent solution of trichloroacetic
acid

Warts, particularly genital or
seborrhœic warts

Rubefacients*Indications**Paints—*

Tincture of capsicum
Ammoniated camphor liniment B P, of
each equal parts

Unbroken chilblains

Ointment—

Resorcin ointment, 24 grains
Carbolic acid ointment, 240 grains
Zinc oxide 120 grains
Soft paraffin, 2 ounces

Broken chilblains

APPENDIX

EXAMINATION FOR LIFE ASSURANCE

IT may be permissible to remind the physician who is unaccustomed to life assurance work that during an examination for life assurance he is for the time being the servant of a company and not the adviser of a patient. Consequently, he should endeavour to give an entirely unbiased opinion on the life, remembering that he is not the "family doctor" putting the best possible aspect on the case in his patient's interest, and that no hint as to the result of his examination must be given to the examinee. Also, it should be borne in mind that in every examination of this nature the examiner's duty is to advise the company whether the applicant's prospects of longevity are "average," "under average," or definitely "bad," an entirely different proposition from that which usually confronts a physician.

The medical referee chosen to conduct a life assurance examination is generally some doctor other than the proposer's medical attendant. The main reason for this practice is that it is obviously unfair to place the proposer's own doctor in the invidious position of deciding between his duty to the office and his natural inclination in favour of his patient. Moreover, the company or its chief medical adviser may require further information on some doubtful point arising out of the examiner's report, and the private medical attendant's views, unprejudiced by any previously expressed opinion, will probably be more helpful in this respect than those of any other doctor.

The medical report form is divided into two parts, the first concerns the proposer's family and personal history, including questions as to the general mode of living. The second part records the results of physical examination of the applicant and concludes with a summary for classifying the life.

Precise information should be obtained from the proposer as to the causes of death of any members of his family and as to the duration of their last illnesses. In attempts to discover

tendencies to disease, a study of the family history is most important. This is especially true in cases where a parent has died of phthisis, as statistics show clearly that among the children of tuberculous parents there is an increased incidence of the disease as compared with that among the population as a whole. Moreover, the risks of developing phthisis are greater during early adult life than after the age of thirty five or forty, and therefore a family history of phthisis is more serious if the proposer is young. If he is under weight or apparently in any way unfit, it is wise in the presence of a family history of phthisis to recommend the office to decline or, at any rate, to defer the proposal. In any case no proposer under thirty five, however fit, should be recommended at ordinary rates if a parent has died of consumption.

After the family history has been dealt with, the applicant is asked whether he has suffered from a number of specified diseases. If the proposer has had any of these diseases brief particulars of the illness, with a note of its duration and severity, should be inserted. If, for instance, an affirmative answer is given to the question regarding consumption, blood spitting, or pleurisy, the date of the attack should be mentioned, whether tubercle bacilli were found in the sputum and whether any X ray photographs of the chest are available. Again, if syphilis is admitted, the date of the primary infection, the duration of the treatment, and the date of the last Wassermann test should be stated. A history of syphilis should always preclude acceptance at ordinary rates, for however thorough treatment may have been, there is always a risk of the development of tabes, general paralysis, or cardiovascular syphilis in middle life. Gonorrhœa without evidence of stricture or other complications is not a bar to acceptance at ordinary rates, provided there has been only one attack. When there have been repeated attacks, the habits of the patient are generally not such as conduce to longevity and the proposal is best declined. With regard to any past history of discharge from the ear, it is important to know when the discharge last occurred.

Following this section of the report questions are asked regarding habits in the use of alcohol and drugs. In the answers to these questions the examiner should recognise that there will be a tendency to understate the amount of alcohol consumed. He should also bear in mind the proposer's occupation and circumstances, both of which may tend to colour his outlook and influence his practice in the matter of alcohol.

This concludes the interrogation of the proposer. While

recording the answers to the questions the examiner will have ample opportunity of forming an opinion not only on the sincerity of the applicant, but also on his general appearance, development, and usual mode of living. Indeed by this time he will probably have formed a shrewd idea of the proposer's chances of being accepted.

The physical examination is now begun and its various sections will be dealt with in the order in which they commonly appear in report forms.

1 *Measurements*—A table of average heights and weights (in ordinary clothes) is appended (*vide* p 1124). Offices usually allow considerable deviation from the "average" where the examination is otherwise favourable. Some companies fix a definite percentage above or below the average as the limit within which lives can be accepted at the ordinary rates. This method, however, can hardly be regarded as a satisfactory way of dealing with any abnormality. A far better standard for judging "overweights" should be the distribution of fat, remembering that heavy persons are not as a rule good risks, particularly where there is a tendency to obesity. On the other hand, "light weight" by itself should not be considered an unfavourable feature, provided that it has been constant, that the chest expansion is good and the family and personal histories unexceptionable. In all cases a chest expansion of 2 in. should be regarded as the minimum. It may be necessary, in some instances, to measure the expansion more than once, owing to the proposer's faulty method of breathing. An abdominal measurement exceeding the girth of the unpanded chest is always an unsatisfactory feature, and such proposers can rarely be accepted at ordinary rates.

2 *Cardio vascular System*—Note briefly, but exactly, any abnormality of the heart. If a murmur is present, a note should be made as to its timing and character. In the case of systolic murmurs, it is particularly important to state whether they disappear with respiration or vary according to posture. Systolic murmurs which are functional in character are no bar to acceptance at ordinary rates.

A blood pressure estimation is essential for all proposers over forty. The first attempt may give an unduly high reading often due to nervousness or excitement, and subsequent readings may be quite normal. A systolic pressure persistently over 150 especially in proposers between forty and fifty years of age may indicate the onset of hyperpiesia, and such cases should rarely be recommended for acceptance even with an increased premium. Low pressures, provided

they are not below 100 and the proposal is unexceptionable in other respects are not of real significance. Diastolic pressures over 100 always indicate pathological hypertension.

The pulse rate when first taken is often unduly rapid owing to nervousness but a later reading may show it to be within normal limits. When tachycardia of nervous origin is suspected the proposer should be given an exercise tolerance test (*vide* p. 493). This will often reduce the pulse rate to normal. Extra systoles in a young man are often without pathological significance but when they occur over the age of forty they must be viewed with suspicion.

3 *Respiration*.—Special care is necessary when the family or personal history reveals any chest complaints.

4 *Digestion*.—The condition of the teeth is now recognised as a factor of considerable importance.

Should a proposer admit to attacks of dyspepsia the possibility of organic disease must not be overlooked. When there is a history of gastric or duodenal ulcer it must be ascertained whether a gastrojejunostomy has been performed, the date of the operation and the subsequent history. Such lives are rarely acceptable at the ordinary rate of premium and until two years at least after the operation should not be accepted at all.

5 *Genito-urinary System*.—A specimen of urine is always required. It should be passed in the examiner's presence and is then examined for albumen and sugar. Albuminuria is frequently found at life assurance examinations in persons under twenty five years of age. The practice of most offices is to require three further specimens at later dates, at least one of these should be examined microscopically. Provided all the subsequent specimens are free of albumen the life may be recommended at ordinary rates. The discovery of sugar in a young proposer may be of small significance but such a case always demands a most thorough chemical investigation. Albuminuria or glycosuria in older people is a more serious matter and such cases must usually be declined.

Conclusion.—A definite opinion should always be expressed as to whether the life is an average risk, acceptable at ordinary rates, or an under average risk which might be taken with a loading, or whether the proposal should be deferred or declined. Where the life is not an average one a brief statement should be made of the grounds on which such a decision has been reached.

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HEIGHTS AND WEIGHTS

MALE LIVES

A Table deduced from the records of seven Life Offices in respect of 28,697 Medical Examinations for Assurance made during the years 1921 and 1922 (weight clothed).

(By permission of the Institute of Actuaries)

Age next Birthdays	HEIGHT								
	5' 4"	5' 5"	5' 6"	5' 7"	5' 8"	5' 9"	5' 10"	5' 11"	6' 0"
	st. lbs.	st. lbs.	st. lbs.	st. lbs.	st. lbs.	st. lbs.	st. lbs.	st. lbs.	st. lbs.
20	8 12	9 1	9 5	9 8	9 12	10 2	10 5	10 9	10 13
21	8 13	9 3	9 6	9 9	9 13	10 3	10 6	10 11	11 1
22	9 0	9 4	9 7	9 11	10 0	10 4	10 8	10 12	11 2
23	9 1	9 5	9 8	9 12	10 1	10 5	10 9	10 13	11 3
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